SILICON CHIP

Australia's World-Class Electronics Magazine!

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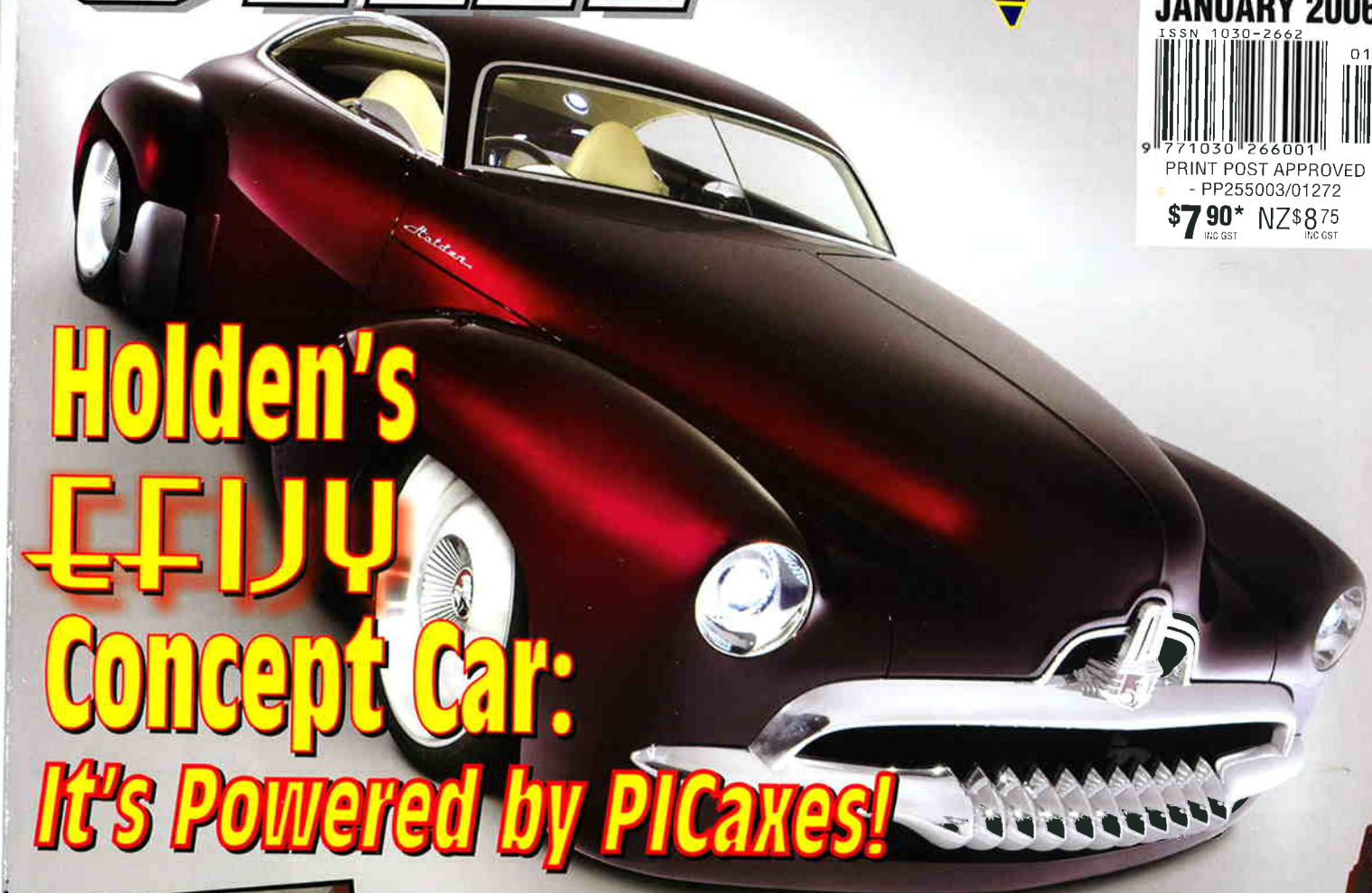

Holden's EFIJY Concept Car:
It's Powered by PICaxes!

- Pocket TENS unit – for drug-free pain relief
- "Little Jim" — AM Transmitter for use with vintage radios
- Building the Ultimate Jukebox

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Publisher's Letter

Australia should build nuclear power stations

Australian cities are facing power shortages and we need to build new power stations to keep up with the demand. The New South Wales state government has just announced the intention to build two new gas-fired power stations (300MW & 400MW) and that is a good move, especially as they have not opted for coal-fired stations. We have been against the building of new coal-fired stations in Australian for quite a few years now. But the new gas-fired stations are mainly intended for meeting peak loads, not base load. Ultimately, New South Wales and other states are going to need more base load power stations. And in the past, the only option has been coal-fired. Renewable power such as hydro, wind and solar can only take us so far, since they can only make a relatively small contribution (say 20% maximum) to the overall energy mix.

But coal-fired stations are no longer an attractive option. For a start, Australia is already being pilloried for its large carbon dioxide emissions and more coal-fired stations will only make that worse. Second, open-cut coal mines are an enormous blight on the landscape – hundreds of square kilometres of open-cut scar has to be seen to be believed – and extremely costly to restore and re-vegetate. And you can forget these weird schemes for underground carbon dioxide sequestration – that just ain't gonna happen in spite of there being at least one small installation overseas.

So that leaves nuclear power. And why not? There is no pollution in normal operation (apart from the huge amounts of waste heat produced, as with any thermal power station). Nor is there any huge mining scar – we already have several uranium mines which could easily satisfy Australia's demand. And we will eventually be storing long-term nuclear waste in the Northern Territory, following recent enabling legislation. So why not take the next logical step and build some nuclear power stations?

The first one could be sited next to the proposed Sydney water desalination plant at Kurnell. This will need a great deal of power and it just makes a lot of sense to build the power station next to it, just as Perth's desalination plant will be built next to the existing Kwinana power station. To make it worthwhile, the proposed nuclear power station should not just meet the demands of the desalination plant when it is operating but also make a reasonable contribution to Sydney's base load. In fact, if possible, it would make sense to power the desalination plant only at night and provide base power during the day. That probably means a rating of at least one Gigawatt but perhaps it should be substantially bigger, so older inefficient coal-fired stations can be taken off line.

Sure, there will initially be a huge outcry from those people who are paranoid about nuclear power but tens of millions of people in the UK, Europe, Japan and the USA have managed to live happily near nuclear power stations for decades so why should we be any different? But has any Australian government got the gumption to do it?

Leo Simpson

Innovative • Unique • Interesting • Hard to find products

12v Mini PC

This mini barebones PC is based on the VIA Eden 800Mhz processor and mother-board. It can operate on 12v or 240v making it ideal for use in boats or cars.
Cat 1167-7 $750

PCI-X Serial Card

Add two RS232 ports to any system with low voltage 32 or 64bit PCI slots.
Cat 2870-7 $149

GSM/GPRS Serial Modem

A dual band GSM & GPRS modem that is capable of transmitting data, short messages (SMS) & fax messages.
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What's New?

USB DVR Surveillance System

4 Camera Inputs

Ideal for home/office/shop security, users can setup their own security system with easy installation. It is the cost-effective solution to replace VCR tape recorders.
Cat 3575-7 $179

USB to IDE Adapter with Power

HOT PRICE

Easily connect any IDE drives to your PC using a high-speed USB 2.0 port. An external power adapter is included to power drives if necessary.
Cat 6857-7 $39

DVI Booster/Extender

Eliminate the video degradation that occurs beyond 7.5m of DVI cable. The DVI Booster requires no extra power supply, additional wiring or sender and receiver system. Supports resolutions up to 1080p or 1920x1920 up to 30mtrs in distance.
Cat 3587-7 $369

12v ATX Power Supply

Powers a standard ATX PC from a 12v source. Perfect for putting a PC in cars or boats etc. Cat 8551-7 $289

Front Access Bay

HOT PRICE

Never reach behind your PC again!

This 5.25 bay has USB 2.0 ports, Firewire, Power out, Audio In/Out and a 6 in 1 memory card reader.
Cat 6765-7 $129

Cordless Pen Mouse

Ideal for use in confined areas where a normal mouse cannot be used. Also ideal for use with a notebook/laptop.
Cat 9287-7 $107

HOT PRICE

PDA Keyboard Adapter

Use a full size keyboard on your PDA & your PC. Simply flick a switch & this Ir adapter changes between the two.
Cat 9229-7 $69

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Great for servers this RAID device takes two IDE drives and mirrors them. If one drive fails it will work from the other until the faulty one is replaced and then rebuild "on the fly" to minimize downtime.
Cat 2874-7 $569

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Cat IC485S-7 $129

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HOT PRICE

Have all your firewire devices plugged in at once with this 6 port hub.
Cat 2847-7 $74

Wireless VGA Receiver

Using an existing wireless network and the software provided, the user can duplicate and transmit their display to a projector or plasma screen etc. Perfect for schools, boardrooms, lecture theatres etc.
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Easily web enable your serial devices. Available in 1, 2, 4 & 8 port models.
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HOT PRICE

This tiny portable bar-code scanner can store up to 1000 barcodes!
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Cordless Skype Phone

This cordless phone works with Skype and can be used as a standard phone.
Cat 10172-7 $199

Serial over Bluetooth

This unique unit will allow a serial connection to become wireless using Blue Tooth.
Cat 11920-7 $459

Internet Security Router with VPN Server

HOT PRICE

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Cat 10164-7 $669

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MAILBAG

Vale Ray Kelly

I am sure that the Vintage Radio article on "Ray Kelly and the HRSA" published in the December 2005 issue of SILICON CHIP will have been of much interest to many of your readers. Sadly, Ray Kelly passed away on Saturday November 19th, 2005, some 23 years after he set up the HRSA.

He will be greatly missed by the many members that he so willingly assisted over those years.

Warwick Woods, President,
Historical Radio Society of Aust.

BPL will be carefully regulated

It was with some concern that I read your editorial on BPL in the November 2005 issue of SILICON CHIP. BPL has evolved over recent years and in its current format it operates in the USA, Europe and Asia within regulated standards. The Australian regulator, ACMA, will ensure that the same standards apply to any deployment of this or any other technology in our country. Otherwise they will simply refuse to license it.

Also, it is no longer utilities alone that are involved in BPL. The largest investors in BPL are Google and IBM and Intel has recently taken a leadership role in this technology as well.

In addition, I take exception to your claims that the IT organisations, the utilities and the regulators have not thought through the issues that you outline in your editorial or that these utilities would be able, in some way or other, to influence our highly-regarded regulators in Australia and elsewhere. These regulators are independent and are quite capable of making their own decisions on these matters.

I am concerned that the tone of your article could generate unnecessary anxiety in the marketplace. There are no plans anywhere in the world that would see nationwide BPL deployment. At best, BPL might take 10% of overall broadband penetration. Its key markets would be in regional deployment and on the edges of cities, where fixed telecommunications networks are less economically viable.

Furthermore, it is quite possible that BPL is an interim technology, bridging the gap between the current inadequate copper-based networks (which are often unable to deliver true broadband services, especially in regional areas) and the Fibre-to-the-Home networks of the future.

Nevertheless, there will always be areas in Australia where Fibre-to-the-Home will not be feasible and both wireless technologies and BPL will have a longer-term role to play in these markets.

Is BPL the final broadband solution? Certainly not but it is an excellent technology which at the very least should be considered for delivery of broadband to areas that otherwise would be under-serviced or not serviced at all.

I have organised three BPL Summits and I invited the radio amateurs to attend these discussions. In addition, upon my advice, they have also been invited to the various industry demonstrations, seminars and trials.

I had hoped the amateurs would take up the invitation to work with the industry to find solutions. Unfortunately, despite several appeals from me, they have declined to do so and their objective continues to be a total shutdown of BPL in Australia.

My argument is that even if BPL were to achieve a 10% penetration, it would take several years to reach that level, during which time there would be ongoing opportunities for fine tuning, reviews and other chances to get it right. Whatever happens, the possible (still not certain) interference to radio amateurs would always be limited, while the benefits to regional BPL broadband users would be enormous. For example, perhaps 1000 amateurs would be affected, while possibly 500,000 regional users would benefit.

I have great faith in our regulators to make sure that the appropriate decisions will be made regarding this technology, decisions which will be in the best interests of our country and which will take into account both amateur radio and the regional broadband users.

Paul Budde,
www.budde.com.au

Paul Budde is an independent telecommunications analyst and commentator. He is working with the utilities and the telecoms industry to develop better infrastructure-based broadband competition in Australia.

Old computers & printers great for components

I like the idea of your "Recycle It" column. At the end of last year, I collected a pile of old (386/486) computers and old printers from our local high-school. Many of the computers were completely unsalvageable and I had no real use for the printers apart from a little laser printer that works like a charm. It took me several weeks but after wrecking the machines I now have an enormous supply of components.

Components were lifted from the motherboards using a heat gun. The printers and a range of 5.25-inch floppy drives yielded a collection of stepper motors, gears and wheels. The old AT style keyboards supplied hundreds of little switches, some of which I have used by mounting them on a custom PC board and fitting them back into a shortened keyboard case. The keys were spray-painted and re-labeled. Using a PIC chip and the original coiled cord, I can connect these custom keypads to any circuit that can accept a serial signal.

At the moment, that means small robots which are driven using the stepper motors I harvested from the

printers. I also have a huge assortment of connectors, piezo and dynamic speakers and ribbon cables which are used on the robots, and logic circuits, most of which of have tested OK. This is not to mention the dozens of LEDs from the computers and printers, as well as PC-board headers that also come in handy. Perhaps you could do an article on what you can get from old (older is better) PCs.

Tim Polmear,
Moora, WA.

Comment: we featured an article on this subject some years ago. As you have found, it is still very worthwhile doing.

Concerns about bilge sniffer

I have some comments regarding the Bilge Sniffer in the September 2005 issue. It is indicated in the article that the device is intended to be used in an area which may contain a flammable vapour (I accept that using this device might of course prevent a larger problem), however the device has no protection technique employed to itself (or the fans which you are proposing to attach to it) to prevent it being a source of ignition.

Such devices would normally have to be certified by a test house (LOSC/ Test Safe in NSW, for example), to some sort of standard.

I would be inclined to at least consult and design the device around those standards even though it might not be tested to those standards. (I am talking about AS2380.1 through to AS2380.7).

At the very least, I would be inclined to have the hydrocarbon sensor located on a cable in the said potentially flammable atmosphere and have the monitor and its heat-generating voltage regulator and a relay in a known safe area. There are some other items that could be attended to, like making sure the hydrocarbon sensor is protected from excess voltage and current.

One really important thing to consider are the fans. Fans are a good source of ignition; they generate static energy and they have brushes, both of which are excellent sources of ignition.

It is not acceptable to push air into a cavity either, as this can disperse gas/vapour into other areas, and not just back outside. See also As-NZS3000:2000, page 212.

Alex Scott,
via email.

Comment: your points are valid but it must be said that the best source of ignition in a boat's bilge is the engine itself. Without some sort of vapour alarm, it is a potential accident waiting to happen.

How to re-transmit a television signal

I would like to comment on your reply to the email from R. F. in the "Ask SILICON CHIP" pages of the November 2005 issue. The email requested information on how to re-transmit a television signal into a valley in which a clear signal cannot be received.

One thing you forgot to mention was that the transmitting antenna at the top of the hill should be in the opposite polarity to the receiving antenna at the top of the hill; eg, if the receiving antenna is horizontally polarised, the transmitting antenna should be vertically polarised. This is to prevent interference between the two antennas, and also between the original signal and the receiving antenna at the bottom of the hill.

I experimented some years ago when the new UHF translators were being installed on the NSW Central Coast. While receiving vertical and horizontally polarised signals with a Wissi EE 06 antenna and a field strength meter, it appears that for a horizontally polarised signal, there is a 25% attenuation between horizontal and 45 degrees and thence a 75% attenuation between 45 degrees and vertical.

The reverse is true for a vertically polarised signal. If memory serves me correctly, the rejection ratio between horizontal and vertical polarisation is in the order of 30dB.

Brad Sheargold,
Collaroy, NSW.

Active TV re-transmission system

Regarding re-transmitting TV signals (page 106, November 2005 issue), I have seen it done on UHF and with the antennas separated by at least 200-300 metres out of line-of-site to avoid positive feedback. I must stress

Atmel's AVR, from JED in Australia

JED has designed a range of single board computers and modules as a way of using the AVR without SMT board design

The **AVR570** module (above) is a way of using an ATmega128 CPU on a user base board without having to lay out the intricate, surface-mounted surrounds of the CPU, and then having to manufacture your board on an SMT robot line. Instead you simply layout a square for four 0.1" spaced socket strips and plug in our pre-tested module. The module has the crystal, resetter, AVR-ISP programming header (and an optional JTAG ICE pad), as well as programming signal switching. For a little extra, we load a DS1305 RTC, crystal and Li battery underneath, which uses SPI and port G.
See JED's www site for a datasheet.

AVR573 Single Board Computer

This board uses the AVR570 module and adds 20 An./Dig. inputs, 12 FET outputs, LCD/ Kbd, 2xRS232, 1xRS485, 1-Wire, power reg. etc. **See www.jedmicro.com.au/avr.htm**

$330 PC-PROM Programmer

This programmer plugs into a PC printer port and reads, writes and edits any 28 or 32-pin PROM. Comes with plug-pack, cable and software.

Also available is a multi-PROM UV eraser with timer, and a 32/32 PLCC converter.

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the area has only a few houses - none on the "ridge line" - and interference to adjacent properties and services is (and must be) nil.

It is an active system, using a UHF-only masthead amplifier (GME is good) of 34dB gain at the four-element phased-array receive antenna with an in-line amplifier of 34dB gain at the re-transmit end.

The re-transmit aerial is a Yagi, with about 102 elements for maximum directivity and set so its polarisation is the opposite of the receive aerial.

A solar panel can be used so the system runs off 12V and be sure to get the injection point on the correct side of the in-line amp so it powers both amplifiers. Quad-shield low-loss cable helps. The reception at 400 metres from the re-transmit aerial is not perfect but is definitely watchable and could probably be honed for better performance.

If someone has a cheap channel-specific translator solution I'd also love to hear about it. They seem to cost in the thousands per channel. I'm sure it shouldn't cost that much to guarantee frequency stability and a low level of emissions, etc.

(Name and address withheld at writer's request).

Long TV feedlines

A letter in the November issue asked about re-transmitting UHF/VHF signals to a house in a valley. Suggestions offered included two antennas and a masthead amplifier. There are other solutions.

Many years ago I saw a similar situation which had been resolved with one antenna at the top of a hill and over 500 metres of telephone line down to the house. I was assured by a local, who was a very competent radio engineer, that it worked extremely well.

The 600Ω pair (two copper wires about 150mm apart with a minimum of insulators and supports) was very low loss and in an electrically quiet location, absorbed little, if any, noise. I have also seen the technique used in a remote area where TV reception was reliable and noise-free in one spot and no signal whatever just 100 metres away (where the homestead was, of course!). Open wire feedline resolved this situation also.

At UHF, this solution may become rather lossy, however "open wire co-axial" feedline (I cannot remember the name of this) may be considered. The feedcones for this are a bit large for VHF but quite practical at UHF.

Geoff Syme,
via email.

Restoration of Ferrograph tape recorders

Owners of the old 1970s classic Ferrograph tape recorders have mostly discovered that all the rubber rollers and pinch wheels have turned into a gooey mess. Mine went this way recently and I have had the good fortune to locate a company in Tasmania that can recondition such parts using more durable materials.

The results are excellent and as most Ferrograph owners would probably read SILICON CHIP, I thought I would pass this information on. The company is Tasroll Engineering Pty Ltd, 373 Brightwater Road, Howden, Tas 7054. Phone (03) 6267 2585.

Graham Lil,
via email.

CO sensor and air-circulation modes

A couple of items in the December 2005 issue attracted my attention. The letter in Mailbag from Graham Goeby concerning "fresh and recirculate modes" in vehicle ventilation systems is quite correct in saying that the control electronics in modern cars will override recirculate mode to allow fresh air into the cabin, as this prevents the buildup of harmful gases. However, what about the large number of vehicles that do not have electronic control of the fresh/recirc system?

My car has air-conditioning but the fresh/recirc system is manual. Now the actuator is electrical over vacuum and the vacuum is supplied via engine manifold vacuum and a small vacuum accumulator which is located inside the left front wheel arch hidden behind the inner arch trim. This ensures very little loss of vacuum when the throttle is opened and the manifold vacuum is lost.

When I hit the recirc/fresh switch, a small electric motor operates the diverter flap and changes the fan air intake from either fresh to recirc or visa versa. This motor is also limited by two microswitches which are actuated by a single cam running off the shaft the flap pivots on.

Using the CO detector to activate the recirc flap is a very good idea. However, having the air system running on recirc when a high concentration of CO is detected is not such a good idea. Surely, running on fresh air would be better then running on recirc air and keeping the carbon monoxide inside the vehicle.

Although, if you were stuck in a traffic jam with the high concentrations of noxious gases present in these situations, having the air system on recirc would seem like a good idea but to be honest, it would only take a small breeze to cut the concentration of gases down dramatically.

In my opinion, using the air system on fresh during times of high CO concentrations is vastly better then recirculating the cabin air and only adding to the gases contained within the cabin.

High CO concentrations in the cabin when you are not stuck in traffic is a sign of a defective exhaust system and this needs to be addressed and repaired as quickly as possible, if not for the health of the driver, then for the health of the passengers. In the case of small children, even a moderate concentration of carbon monoxide can have a serious or devastating effect on the development of a small child, especially a baby!

Secondly, Russell Verdon's letter about scavenging parts from old scanners drew my attention as I use an old scanner as a light box. Powering up the tube within the scanner was very simple and virtually every member of my family use this light box for one thing or another.

My children use it for tracing, my wife uses it for image checking and viewing slides and I use it when I am tracing circuit tracks on double-sided circuit boards, as it allows me to see

both sides of the board and both sets of tracks at the same time. I can also see if all the through-board connections are complete and if all the component lead connection holes are free of debris and blockages. All around, it is a very useful piece of gear.

Dave Sargent,
Howard, Qld.

Comment: we take the view that the carbon monoxide sensor is very sensitive and warns the driver that he/she is driving into unsafe air. In practice, if you can smell traffic fumes while driving, you are inevitably exposed to carbon monoxide, as well as all the other noxious combustion products.

We think it is preferable to switch over to recirculation mode immediately CO is detected rather than to continue to unknowingly breathe traffic fumes for quite long periods. In fact, many people cannot smell traffic fumes at all and so they are always at risk. Of course, if carbon monoxide from the vehicle's own exhaust is leaking into the cabin, then the CO sensor will also detect this.

If you have a headache after a long drive in traffic, it is a fair bet that you are suffering from carbon monoxide poisoning.

Cruise control is very handy

I read the lead article on adaptive cruise controls in the September issue. Cruise controls are very handy – we have one on our Volvo.

I had a discussion with a Bentley owner recently who said he would never use his as he was concerned he could have a medical seizure and not have time to brake. He is middle-aged and fit but it made me wonder. Maybe your staff have a view on this?

Ian McPherson,
via email.

Comment: our view is that cruise controls work well, except in heavy traffic, winding roads and on steep hills. If a person is so fearful of having a seizure, he should not be driving at all.

Flash point and volatility

In the Mailbag pages in the 2005 December issue, the letter on flash point and volatility would appear to be incorrect. Diesel has a flash point above 61.5°C, a vapour pressure of <0.5kPa and an auto-ignition temperature above 250°C.

Unleaded petrol has a flash point of less than -40°C, a vapour pressure of 35-90(reid)kPa and an auto-ignition temperature above 250°C.

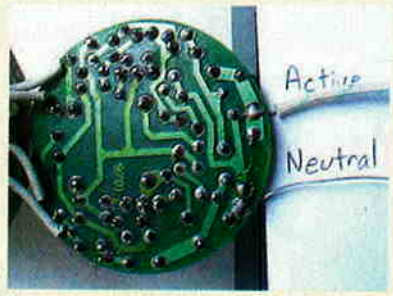
Flash point of a flammable substance is the lowest temperature at which it gives off sufficient vapor to form a flammable mixture with air, so that on application of a flame the vapours will flash, but will not continue to burn.

I feel that the letter states that diesel will flash at a lower temperature than petrol which is not the case. If there is such a thing as a safer fuel, it would have to be diesel.

A look at the Shell website (www.shell.com) will confirm the above temperatures.

Bruce Edgar,
Rockhampton, Qld.

Comment: In practice, to quote from the Shell website, "Volatility characteristics vary on a monthly basis to provide good cold weather starting in winter and to prevent vapour lock in summer. Consequently, petrol should not be stored for long periods".



Compact fluoros revisited

I thought the accompanying photo may be of some interest. I recently opened a dead compact fluoro out of interest and got quite a surprise. The Active and Neutral leads are marked on the photo and you can clearly see that where they enter the discrete diode bridge rectifier; the track spacing is barely 1mm!

Even with a conformal coating, this seems to be stretching things to the limit!

Graham Lill,
via email.

Talk about a generation gap.

The new Tektronix AFG3000 Series signal generators vs. the competition.

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HOLDEN'S EFIJY SHOW CAR

POWERED BY V8, CONTROLLED BY PICAXE

The Holden EFIJY show car was one of the most popular vehicles on display at the 2005 Sydney International Motor Show. While the stunning looks and technology drew the crowds, few people would have been aware that the majority of the electrical systems in the vehicle were controlled by PICAXE microprocessors.

By JEFF BROWN*

HOLDEN INNOVATION IS Holden's research and development centre and one of its functions is to develop and demonstrate new technologies and concepts. Vehicle design is moving more and more into the virtual world but technology still needs to be demonstrated to allow people to decide if they want this in a future vehicle.

Invariably, this requires a demonstration or concept vehicle. The concept vehicle may be based on a current production car and have the new technology integrated into it or in the case of EFIJY, it became a completely new vehicle.

With the increasing complexity of today's vehicle electrical systems and the integration of mechanical and electronic control systems, it can be quite difficult to adapt or modify the base vehicle to accept the new technology, even with the benefit of having detailed information about the vehicle's architecture.

Traditionally, first-tier suppliers provide the components and in some cases the technology used in a given subsystem.

Typical development of a component for production involves a number of charges from the supplier; including design and development charges, tooling charges and, of course, piece cost. When a prototype is produced, the supplier incurs many of the same costs. It costs almost the same to write software for a one-off prototype as a production system. In the case of the production system, the software may be more complex to increase the robustness of the code but most of the requirements will be the same.

A similar issue occurs with hardware. In the case of PC boards, design work still needs to be done, again perhaps not to the same extent as production, but still a significant percentage of the work.

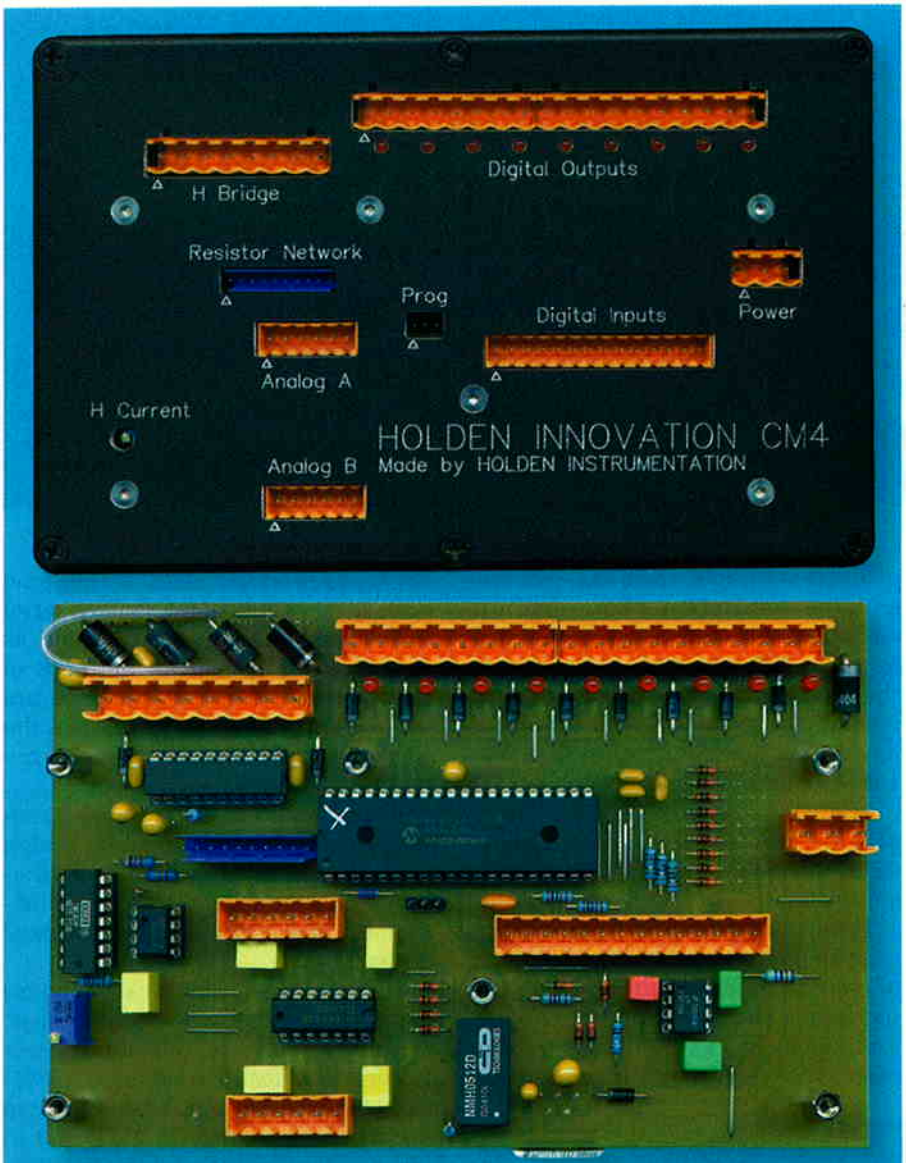
This all leads to significant expense to produce a single working prototype. A simple change to add a customer feature may result in charges of $5-$10,000. A more complex system can see the cost escalate to $250,000 to demonstrate a new technology. Therefore, significant budgets are required. By developing a low-cost prototyping system in-house, Holden is able to investigate and demonstrate new systems at much lower costs and ensure any intellectual property remains with Holden.

LCD panels are used for the large instrument panel screen and for the central touch-screen display.

Why PICAXE?

Many of the engineers at Holden are readers of SILICON CHIP magazine and recent articles about the PICAXE range of microcontrollers sparked some interest due to our previous experience with the Microchip range. The need arose for a relatively simple project and the PICAXE looked like it might be suitable, while giving us the opportunity to evaluate the product.

Our initial selection was the 18X processor and in the target application, it proved to be very competent; the simple interface and relatively



Developed especially for the EFIJY, the CM4 is a general-purpose control module for use in a variety of applications. It uses a PICAXE 40X running at 16MHz and includes a high-current H-Bridge for controlling motors, high-current FET outputs for switching lights, solenoids etc, analog inputs, and digital inputs with jumper selectable pull-ups or pull-downs.

simple BASIC language resulted in very fast prototyping of a concept. Holden Innovation has now used the PICAXE 08, 08M, 18A, 18X and the 40X in numerous applications. Over time the complexity of the projects in which we have utilised the PICAXE for has increased and we now base most projects on the 40X running at 16MHz.

The most interesting aspect of the PICAXE is the number of users, some of whom do not have an electrical background. We have found that the simple interface and language has been readily adopted by students and engineers, and even by hardcore programmers.

EFIJY electronics

With the exception of the engine and transmission control modules, the electronic systems in the EFIJY are unique and are not based on production components. They use a total of 11 microcontrollers: nine PICAXEs and two Atmel AVRs.

The most visible systems when sitting in the vehicle are the large instrument panel screen and the central display, revealed when the centre compartment opens. The two touch screens are LCD panels, each controlled by compact PCs with embedded Windows XP operating systems.

The on-screen images for the touch screens were created by Holden's Design Department specifically for EFIJY and are running in Macromedia Flash. The touch screens interface with Flash and communicate with the outside world via the PC's serial port. This results in each "button press" on the touch screen being transferred to the subsystem the driver intends to control.

A dedicated module based on an Atmel Mega16 programmed in BASCOM handles all serial traffic with the PCs and sends and receives commands from the modules that control most subsystems. A second Atmel micro handles communications with the engine and transmission CAN (Controller Area Network) networks for data such as RPM and vehicle speed for display on the instrument panel and also controls the ignition and start systems.

CM4 control module

Holden Innovation developed the CM4 module as a general purpose control module that could be used for a variety of demonstrator applications. It's called CM4 because it is the fourth in a family of control modules developed by Holden Innovation.

The heart of the CM4 is a PICAXE 40X running at 16MHz. This module has a high-current H-bridge with current measurement for controlling motors, high-current FET outputs for switching lights and solenoids, etc, plus analog inputs and digital inputs with jumper-selectable pull-ups or pull-downs.

In addition, a resistor network is employed for resistor-encoded switching to further increase the number of available inputs. This is achieved using one of the 40X's analog inputs and a resistor ladder; by switching points on the ladder to ground, 10 steps at 0.5V per step is achieved. Therefore, the 40X can process 10 different inputs on the one analog input.

The power supply is capable of providing 5V for various sensors and the PICAXE has the ability to control and switch its own power supply off for any house-keeping required before a controlled system shutdown. This is very handy for functions that need to be controlled after the ignition has

been turned off. The usual PICAXE features such as serial communications, I²C, etc, are also available.

PC board design and fabrication of the CM4 was conducted in-house by Holden's Instrumentation department. EFIJY uses four CM4 modules for the following subsystems.

ePark Brake

EFIJY is fitted with an electric park brake which offers a number of features, including removing the need for a large and bulky lever. The pushbutton is pressed to apply and pressed to release the parking brake. In the event the parking brake is required as an emergency brake, the rate of brake application limits the vehicle deceleration to 0.3G.

Operation of the system is via an actuator operating on a conventional park brake system located within the rear wheels. This actuator is controlled via the H-bridge and uses both positional feedback and current through the H-bridge. This allows the system to be self-adjusting and provides the control algorithm with a measure of load applied.

Entry and exit

Entry and exit from the vehicle is interesting, since there are no door handles in or outside the vehicle. Pushbutton switches for the doors and boot use the resistor encoded inputs to the CM4 module to control release solenoids.

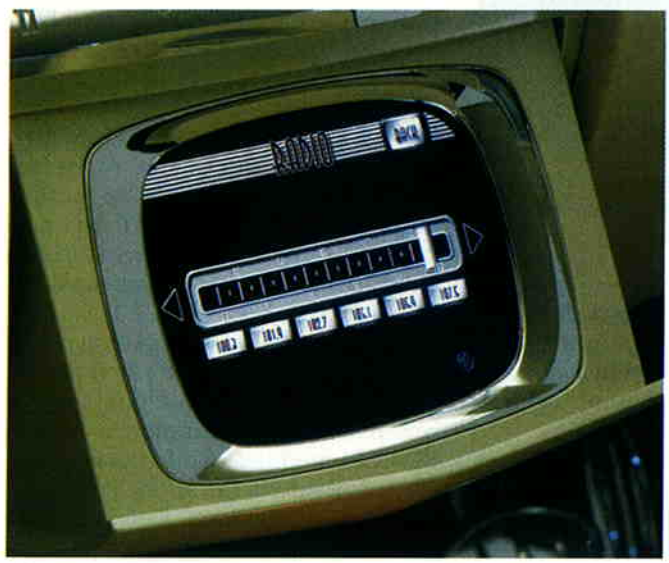
There is also a custom remote control based on a surface-mount version of the PICAXE 08M. This operates on 433MHz and has three pushbuttons that release the doors and boot in a conventional manner. The vehicle responds to the command from the remote and starts a power-up sequence to ensure all systems are ready for operation when the driver enters the vehicle.

The third method of entry is via a passive entry system. The operator walks up to the car, holds out his/her hand and the door pops open to meet it. In this mode, the vehicle detects the presence of a valid remote.

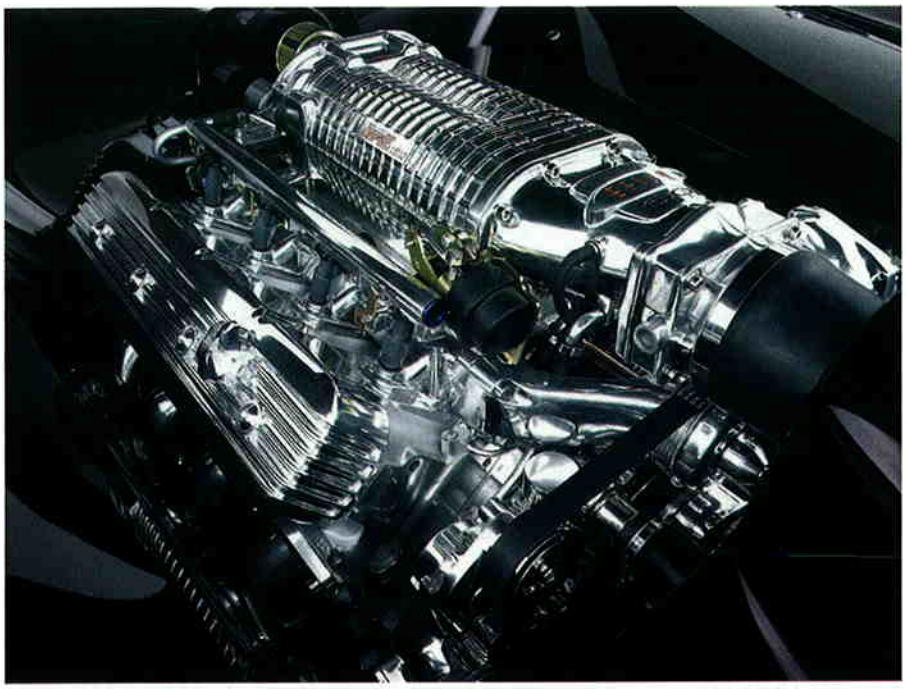
This is achieved using a multi-axis motion sensor controlling the power supply in the remote. This allows the remote to power up for brief periods. A unique message is then transmitted but only if the remote is moving. This significantly increases battery life – if the remote is in storage or not in use, the power supply to the 08M is off.

When this message is received by the CM4, the door proximity sensors are enabled. These use a capacitance type proximity sensor based on the

The driver selects the gear by pushing one of the buttons located on the centre console. These buttons use the resistive encoded inputs on one of the CM4 modules, while the actuator (which controls the transmission) is controlled via the H-bridge output.



The central display is revealed when the centre compartment opens. It displays touch-screen images (controlled by compact PCs) to control functions such as the radio and the suspension settings.



A 6-litre LS2 V8 fitted with a supercharger sits in the engine bay. It develops 480kW of power and 775Nm of torque.

The headlamps use 20 high-brightness LEDs in the centre, while the outer rings use 36 pairs of white and amber devices (the latter for turn indication).

When a valid remote transmitter is detected inside the passenger compartment, the engine can be started by briefly pressing the large Start button to the left of the steering column. Pressing it again stops the engine.

QT110 IC which provides a digital output when an object is detected.

In operation, the device continuously adapts to its environment and only reacts to step changes in capacitance. An output from the proximity sensor is generated by the presence of the driver's hand at a range of approximately 80-100mm from the top rear edge of each door. The combination of a valid remote in range and the driver's hand allow the door to be released. In addition, various interlocks in the code determine if door operation is permitted, based on door position, vehicle speed, ignition status, etc.

Naturally, the occupants still need to manually close the doors!

Starting

EFIJY has a 6-litre LS2 V8 engine fitted with a supercharger. It develops 480kW of power and 775Nm of torque.

You start the engine with the large pushbutton on the left of the instrument cluster. Starting is controlled by one of the Atmel Mega16 microcontrollers, which provides interface to the power control and engine management systems of the vehicle.

When a valid remote transmitter is detected within the passenger compartment, the start button flashes to indicate that the engine can be started. Pushing the button for a brief period then starts the engine. To stop the engine, the start button is pushed again. Various interlocks ensure that the engine is not cranked if it is already running.

Alternatively, a key can be used to turn on the ignition and the start button used to crank the engine.

ePRNDL

ePRNDL stands for "electronic Park Reverse Neutral Drive Low" – the electronic transmission selector located in the centre console. EFIJY uses a 4-speed GM automatic transmission, the 4L60E, with the cable control replaced by an actuator.

The driver selects the gear by pushing one of the buttons located on the centre console. The buttons use the resistive encoded inputs on one of the CM4 modules, while the actuator is controlled via the H-bridge output and utilises positional feedback from both the actuator and the transmission's internal controls.

The CM4 is also responsible for

switch illumination, and selected gear position feedback, both to the driver and to other subsystems. Naturally, a number of interlocks are employed to ensure accidental operation is avoided, to prevent damage to the vehicle.

Proportional speed control of the actuator is used to ensure fast response as well as accurate selection of the correct gear position

Air suspension

The car is fitted with integral air-bag and damper assemblies and each wheel has an analog suspension height sensor. Compressed air is supplied via an onboard compressor and storage tank. A manifold with eight solenoid valves, four for lift and four for lower, together with the CM4 module, controls the air supply to each airbag to maintain the desired trim height, regardless of load in the vehicle. There are three settings: show, drive and load and the height can be controlled to within approximately 1mm.

The CM4 receives the target height request from the central touch screen. Using the EEPROM in the PICAXE, the last requested suspension height is tracked to allow for system power loss.

In a show vehicle, there is usually an isolator switch for the vehicle battery. This is turned off when the vehicle is in storage or on display. But because of the non-volatile memory (EEPROM) in the PICAXE, the control module knows what height it should be at when power is reapplied. The software inhibits control of height when the vehicle is moving and includes error detection and reporting.

Steering column lock

Setting the suspension to the show position requires the front wheels to be centred inside the front wheel arches. If this does not happen, the wheels will make contact with the fenders and result in body damage.

This problem was solved using an analog steering angle sensor, similar to the type used for stability control systems. This allowed the CM4 module to determine if the steering wheel was centred and if not, allow the central display to indicate not only the need to centre the wheel but also the direction the wheel needs to be turned. When the wheel is in the correct position, a locking actuator is engaged to prevent the steering wheel being turned when the car is in the lowered position.

Eight high-brightness red LEDs are used in the stop indicator housing that's mounted on the boot lid.

The locking actuator is a rack type and requires an H-bridge to drive it to the lock and unlock positions, while integral position switches provide lock status. Again, various interlocks are employed to ensure the steering column is not allowed to lock when the vehicle is in motion.

Lighting

The headlamps use Osram Ostar LEDs. These consist of a cluster of five 1W LEDs mounted on a single substrate. With four of these clusters per lamp, there is approximately 20W of LED illumination per side. The outer rings contain 36 pairs of LEDs, one white 50mA device and one amber 150mA device per aperture.

The tail lamps consist of 32 dual colour LEDs and a single blue 1W Dragon LED. The dual colours provide stop and tail functions by control of the current through the red elements. When a turn signal is required, the amber LEDs are strobed to provide the flash function.

A 40X PICAXE running at 4MHz is used in each tail lamp assembly.

LED lighting is also used for interior illumination, as well as for switches and warning lamps.

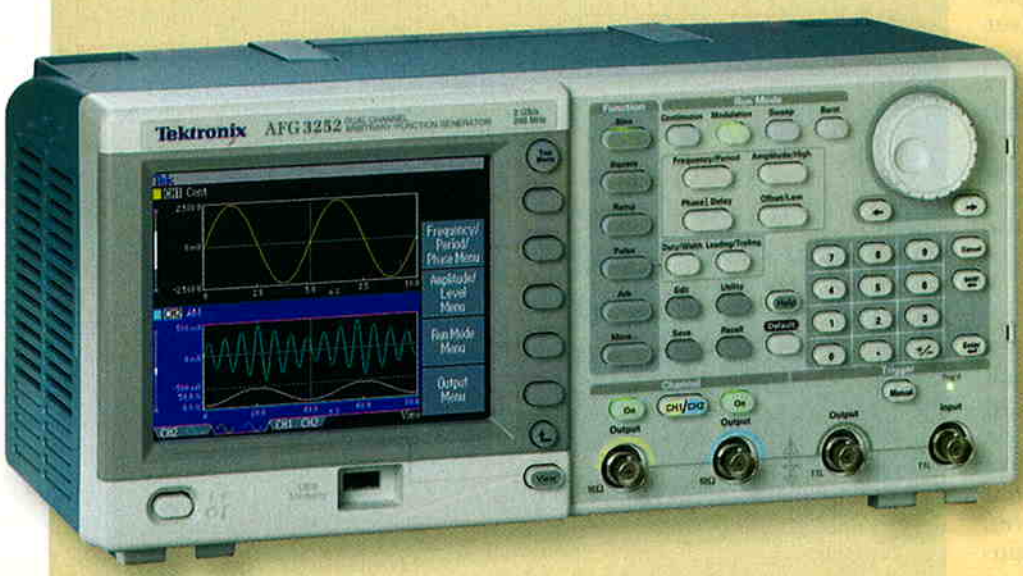
Collaboration

The electronic systems in EFIJY were the result of a collaboration of several departments within Holden, as well as a number of suppliers who contributed components or assemblies to allow EFIJY to be a fully functioning, fully-drivable demonstration of future vehicle technologies.

The tail lamps use 32 dual-colour (red and amber) LEDs to provide the stop and turn indicators.

About the author*

Jeff Brown is the Technology Leader – Flexible Architecture at Holden Innovation. During his 19 years with Holden, amongst other duties, he has been responsible for powertrain management systems, vehicle networks and electrical systems architecture. SC



We test-drove the low-end AFG3022 model, which is visually identical to the AFG3252 pictured here. It can generate sinewaves at up to 25MHz and pulse/square/arbitrary waveforms to 12.5MHz. The arbitrary waveform sample rate is 250MS/s, with internal memory space for four 64kbyte waveforms.

Tektronix AFG3000 Series Arbitrary/Function Generators

Tektronix has just announced a new range of arbitrary/function generators. Dubbed the AFG3000 Series, the line-up includes six models, ranging from a basic single-channel model to dual-channel models with high bandwidths and fast sample rates. All instruments can generate function (sine, ramp, etc), pulse and arbitrary waveforms and are backed by a stable, low-drift (±1ppm per year) timebase.

By PETER SMITH

At the bottom end of the range, the AFG3021 can generate sinewaves at up to 25MHz and arbitrary/pulse waveforms to 12.5MHz. The arbitrary waveform sample rate is 250MS/s, with the ability to store four 64kb waveforms on-board. The other major difference with this lower-cost model is that it includes a monochrome rather than colour LCD.

The AFG3252 dual-channel model tops the range, with 240MHz sinewave generation and a 120MHz arbitrary/pulse waveform capability. Naturally, it supports a higher sampling rate of 2GS/s and has enough memory for four 128kb waveforms.

All models boast a frequency resolution of 1µHz (12 digits) and a vertical resolution of 14 bits.

Other important features across the series include amplitude, phase and frequency-modulated signal generation, as well as linear/log sweeps and bursts. Also of note is the pulse generator's independently programmable rise and fall times – a feature previously unavailable at this price range, according to Tektronix.

The ability to independently program waveform and frequency settings for each channel on dual-channel models highlights the flexibility of these instruments. Independent channel control has allowed Tek engineers to add other niceties too – like the ability to tweak phase relationship between channels!

It all stacks up

To capitalise on bench space, these new instruments can be stacked along with Tek's TDS1000, TDS2000 and TDS3000 series oscilloscopes, thanks to the now familiar "shoe box" form factor. We reported on the latter two series in the July 2001 and July 2002 issues and remain impressed with Tek's lightweight, portable instrument designs.

Unlike the 'scopes, the AFG3000 series don't include floppy drives. Instead, they feature an up-front USB socket that accepts standard flash

memory drives. This obviously makes it very easy to save and exchange waveform suites and instrument set-ups.

Other similarities with Tek's oscilloscopes are immediately apparent. All models feature a large 5.6-inch LCD, which together with the relatively simple front-panel interface and on-screen menus make these models very easy to use. One particularly nice feature is the ability to see a graphical simulation of the generated waveform on-screen, in many cases eliminating the need to monitor the output with a scope.

Waveform editing & creation

Generating any of the 12 standard waveform shapes is straightforward and can be achieved in seconds with a few keystrokes. However, using the arbitrary waveform generator to create your own wave shapes can be a different matter.

With the aid of "soft" keys, the numeric keypad and the rotary dial, it's possible to define all of the points necessary for creating a new waveform, using the built-in "edit" memory as your workspace. The result can be viewed on-screen, saved in one of the four memory slots and transferred to a USB memory stick for later retrieval.

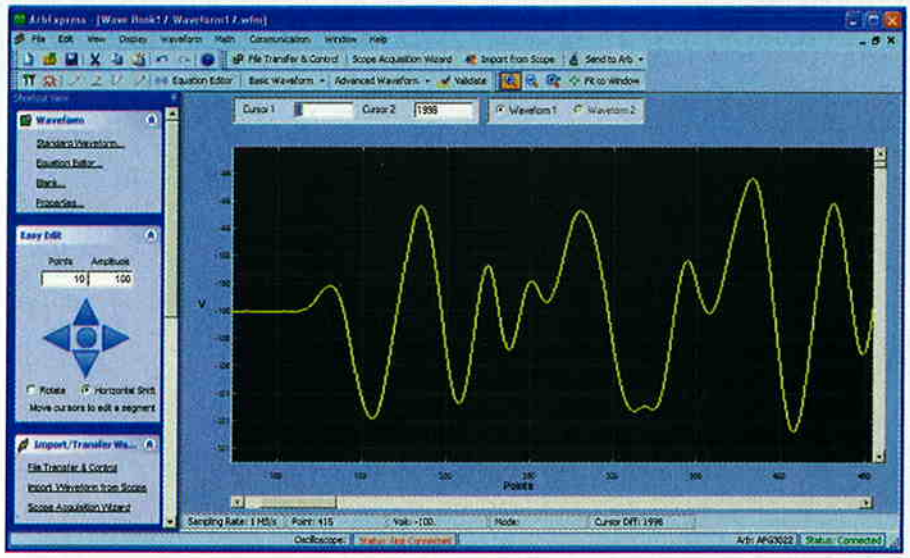
However, this method of creation could be extremely tedious, particularly if the task involves replication of a complex real-world analog signal. The answer is to install Tek's ArbExpress software on a PC and use that to create all your waveforms.

This highly useful application allows you to create and edit waveforms in a variety of ways. For example, you can manually create a waveform using the straightforward point-and-click interface or define it mathematically and have ArbExpress generate a representative plot. This is significantly easier than creating the waveform on the instrument itself.

For direct waveform replication though, there's an even easier way – just acquire or import it from any of Tek's digital scopes! Alternatively, you can transfer a waveform directly out of MatLab (no conversion is necessary), or import it in CSV format from a variety of sources. What a timesaver!

Networking & remote control

Once created, waveforms can be transferred to the instrument via a USB memory stick or uploaded from within ArbExpress using a direct PC-to-instrument USB connection. A second USB connector is located at the rear of the instrument for this purpose.



ArbExpress 2.0 software runs on Windows PCs and makes creating your own waveforms as painless as possible. New waveforms can be created manually, defined mathematically or imported from a Tektronix digital 'scope. MatLab users can also bring in their creations without intermediate conversion.

The AFG3000 series can also be controlled remotely via USB, GPIB and LAN interfaces. In fact, ArbExpress includes a rudimentary control interface. Note, however, that the latter two interface types are not present on the lower-cost AFG3021 and AFG3022 models.

ArbExpress 2.0 is a standard part of the instrument package and is included on CD-ROM with all models.

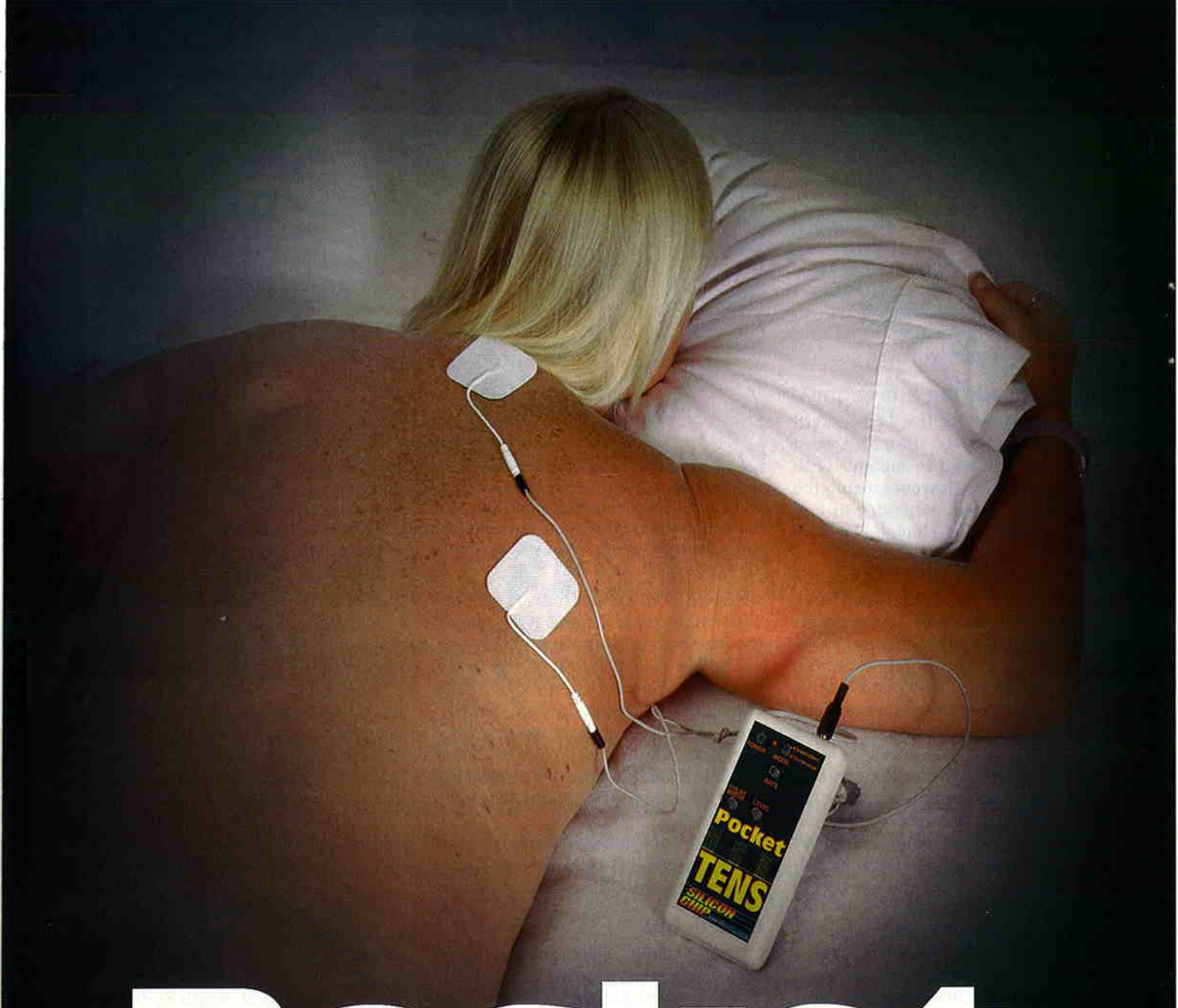
Bottom line

The AFG3000 Series arbitrary/function generators are easy to operate and offer excellent performance for their price. Tektronix claim that for applications requiring signals with sampling rates of 1GS/s or more, the AFG3000 Series can save purchasers up to 75% of the cost when compared to many other high-performance products.

The higher bandwidth models in the series will no doubt appeal to designers developing high-performance computing, communications and video equipment. The more basic models will attract users in educational institutions, as well as designers of consumer electronics and medical and automotive systems.

The Tektronix AFG3022 costs $3863 (including GST), while the other models that make up the 3000 Series cost from $2546-$12,160. For further information, contact NewTek Instruments Pty Ltd, 3 Byfield St, North Ryde 2113 – phone (02) 9888 0100. Or go to **www.newtekinstruments.com**. **SC**

Right: plug-in USB flash drives allow instant loading and saving of waveform data and set-ups. A second USB slot is also located at the rear of the instrument, for connection to a PC.



Pocket TENS

By John Clarke

TENS – Transcutaneous Electrical Nerve Stimulation – is pain relief without drugs. Attach electrodes near to the painful area and start up the TENS unit for a tingling sensation that can help to reduce pain. The pocket-sized SILICON CHIP TENS unit has adjustable controls that tailor the levels to suit each patient's requirement and is battery powered.

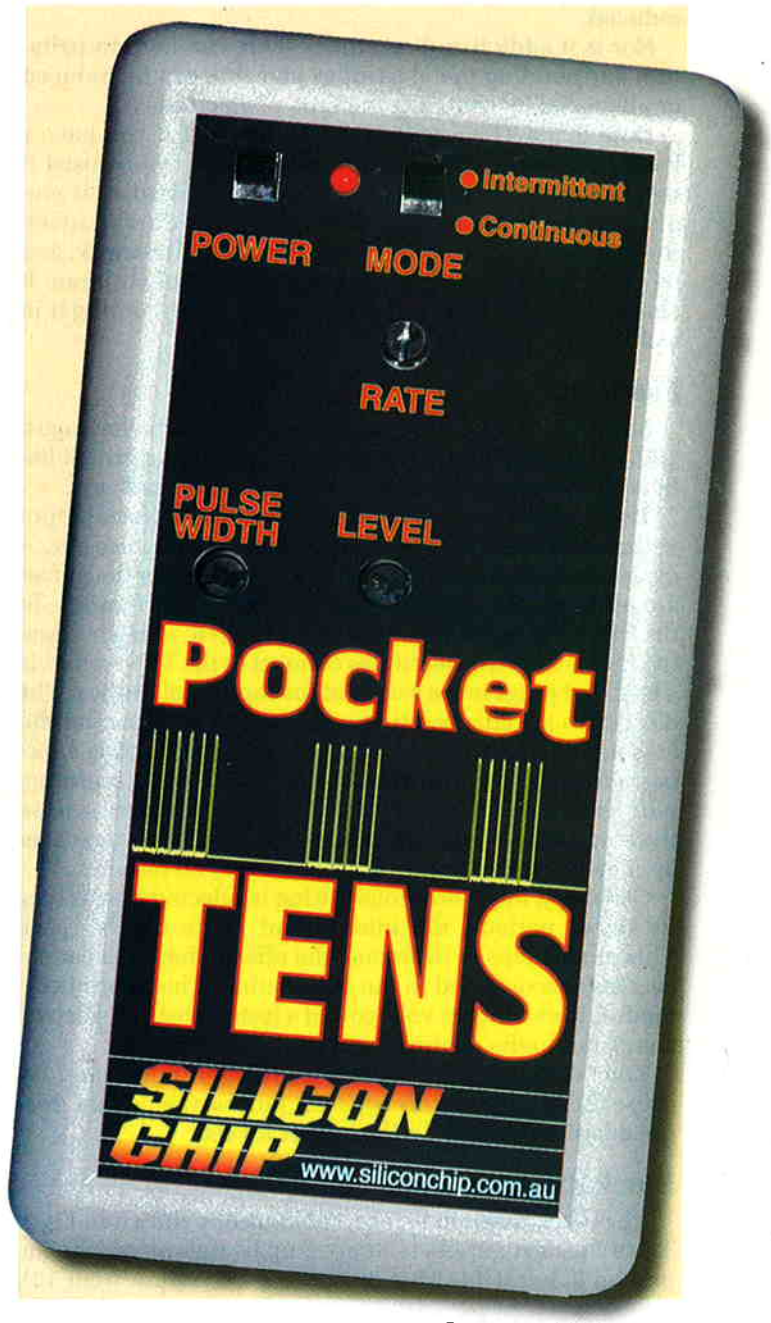
Features
- Battery powered
- Adjustable voltage level
- Adjustable pulse rate
- Adjustable pulse width
- Intermittent or continuous output

Living in constant pain is a reality for many people and how well they cope with it depends on the degree of pain and the character of the person.

While pain relief can be managed in the short term using analgesics, their long-term use can be detrimental to the user's health. Side effects of prolonged analgesics use include liver and kidney damage and in some cases irritation to the lining of the stomach. Thankfully, in many cases there is an alternative: TENS or Transcutaneous Electrical Nerve Stimulation.

In many cases where pain is constant, a medical practitioner or physiotherapist may recommend the use of a TENS unit.

These are not a gimmick or a new-age form of treatment. Tests have shown that TENS is an effective and safe way to manage chronic and acute pain with virtually no side effects. Chronic pain conditions that can be alleviated with TENS include, arthritis, lumbago, neck and back pain, post herpetic neuralgia and sciatica. Acute pain conditions such as fractures, muscular pains, post operative pain and



Warning!

This TENS unit (or any other similar device) must not be used on a person who has a Heart Pacemaker.

Do not connect the electrodes to the body so that there can be a flow of current through the heart.

Electrodes must not be placed on the neck, since this can stimulate nerves which control breathing and blood pressure.

Do not use the TENS unit for headaches or attach the electrodes to the head.

Do not be tempted to run the TENS unit from a mains adaptor, plugpack or power supply. This could be dangerous if a breakdown occurs in the isolating transformer. If you want to reduce the cost of battery replacement, we suggest using a 9V NiMH rechargeable battery.

tennis elbow can also be managed with a TENS unit.

A TENS unit provides electrical stimulation of the painful area using electrodes attached to the skin. It can cause a tingling sensation in the area where the pads are attached. How the TENS reduces pain is unknown. Some suggest that the nerves are stopped from sending signals to the brain and thus the pain is removed. Alternatively, the stimulation could induce the body to produce natural pain relieving substances called endorphins.

Whatever the reason, a TENS unit can give pain relief for many people, with minimal side effects. It does not provide a cure for the underlying cause of the pain but has the major benefit that the amount of pain killing drugs can be substantially reduced.

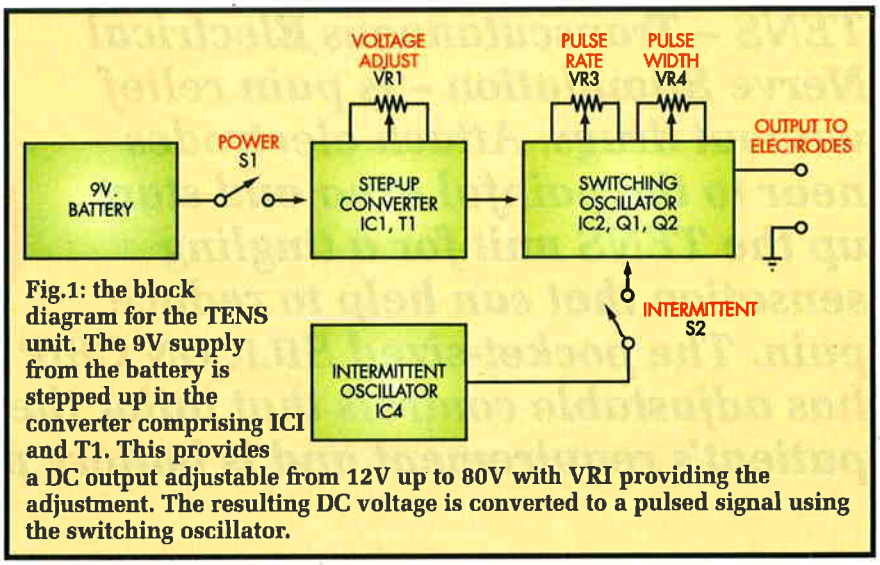


Fig.1: the block diagram for the TENS unit. The 9V supply from the battery is stepped up in the converter comprising ICI and T1. This provides a DC output adjustable from 12V up to 80V with VRI providing the adjustment. The resulting DC voltage is converted to a pulsed signal using the switching oscillator.

Nor is it addictive. Sometimes there can be skin irritation surrounding the electrodes and this can be reduced or alleviated by changing the type of electrode.

Note that a TENS unit must not be used if you have a heart pacemaker. A TENS unit also should not be used if the cause of the pain has not been established or if you are pregnant. When using the TENS unit do not attach the electrodes anywhere around the front of the neck, and be sure the TENS unit is kept out of reach of children. It should be treated like any other medicine, by storing it in a childproof cabinet.

Features

SILICON CHIP previously featured a TENS unit in the August 1997 issue. This new version uses a very similar circuit but housed in a much-more-convenient pocket-sized case.

Three small knobs allow adjustment of the overall output voltage, the width of the voltage pulses and the pulse rate. A continuous/intermittent switch selects whether the pulses are provided as a continuous stream or in short bursts. To the left of that is a power switch and a LED to indicate when the unit is on. Two electrodes connect to the TENS unit via a lead that plugs into a socket at the top end of the box. The electrodes are attached to the skin adjacent to the painful area and the controls are adjusted until the tingling effect becomes just a little uncomfortable. The tingling sensation will tend to decrease over the period of treatment and so the controls will need to be further increased as time goes by. The typical treatment period is about 20 minutes.

Generally, the continuous setting is selected but for long treatment periods, the intermittent mode can be used. This mode helps to overcome the effect where the patient becomes accustomed to the stimulation. The intermittent mode allows a higher voltage and a faster rate to be selected compared to the continuous mode.

Thus the stimulation is greater in short bursts and because there is a break in between pulses, the patient does not adapt too readily to the higher levels.

Block diagram

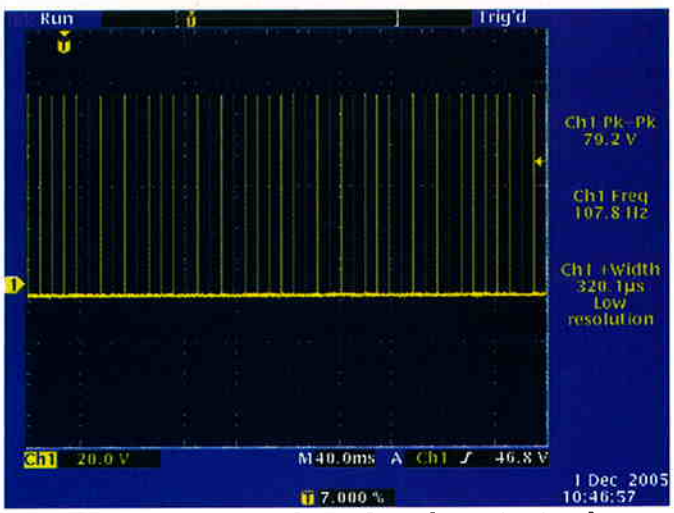
The block diagram for the TENS unit is shown in Fig.1. The 9V battery supply is stepped up by the converter comprising IC1 and T1. This provides a DC output from 12V to 80V, with VR1 providing the adjustment. The resulting DC voltage is converted to a pulsed signal using switching oscillator IC2. Oscillator IC4 is switched into circuit via S2 to gate the switching oscillator to give short bursts of the pulsed signal.

Fig.2 shows how the basic step-up converter circuit operates. It comprises inductor L1 which is charged from the V+ supply through transistor Q1. The charging current is shown as I1. When the transistor is switched off, the stored energy in L1 is dumped via diode D1 into capacitor C1.

The actual voltage across C1 depends on the amount of charge in L1 and the load current between Vout and the ground supply. We can maintain a constant Vout for a variety of loads by controlling the amount of time Q1 is switched on.

Fig.3 shows the circuit of the switching oscillator, comprising IC2, Q1 & Q2. This modulates the output voltage of the step-up converter and is based on an IR2155 made by International Rectifier Corporation. It is described as a high-side self-oscillating power Mosfet gate driver.

Resistor R1 and capacitor C1 at pins 2 & 3 of IC2 set the rate at which Mosfets Q1 and Q2 are alternately turned on and off. There is a dead time of 1.2µs between each device



This oscilloscope screen shows the pulse train signal at the electrodes. Here the voltage is set at 80V and the frequency at 108Hz

siliconchip.com.au

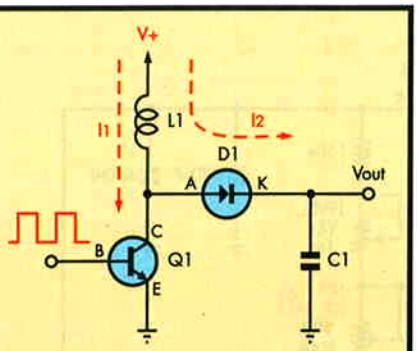


Fig.2: how the basic step-up converter circuit works. Inductor L1 is charged via transistor Q1 from the V+ supply. When the transistor is switched off, the stored energy in L1 is dumped through diode D1 into capacitor C1.

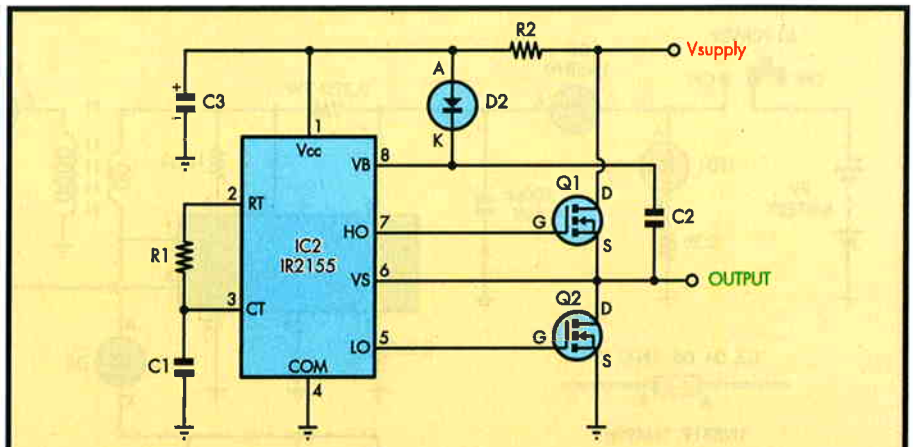


Fig.3: the circuit configuration of the switching oscillator. This modulates the output voltage of the step-up converter. D2 and C2 constitute a diode pump to boost the supply voltage to correctly switch Q1.

switching off and the other switching on. This prevents the supply from being short circuited at the switchover period when one Mosfet turns off and the other turns on.

Diode pump

Note that the supply voltage for IC2 is around 10V while the voltage to be switched can be up to 80V. The gate voltage for Q1 must be raised above its drain by several volts in order for it to be able to switch the 80V supply. This extra voltage is derived using a diode pump consisting of diode D2 and capacitor C2.

Initially, the supply to pin 1 of IC2 is set at about 10V by an external zener diode. When Mosfet Q2 is switched on, capacitor C2 charges to the 10V supply via D2. When Q2 is turned off, pin 7 is connected internally to pin 8 to switch on Q1. Q1 then pulls pin 6 up to V_{supply} and pin 8 is level-shifted to V_{supply} plus the voltage across C2. So in a few switching cycles, the circuit automatically shifts pin 8 and thereby the gate voltage to Mosfet Q1, to whatever the driving voltage needs to be.

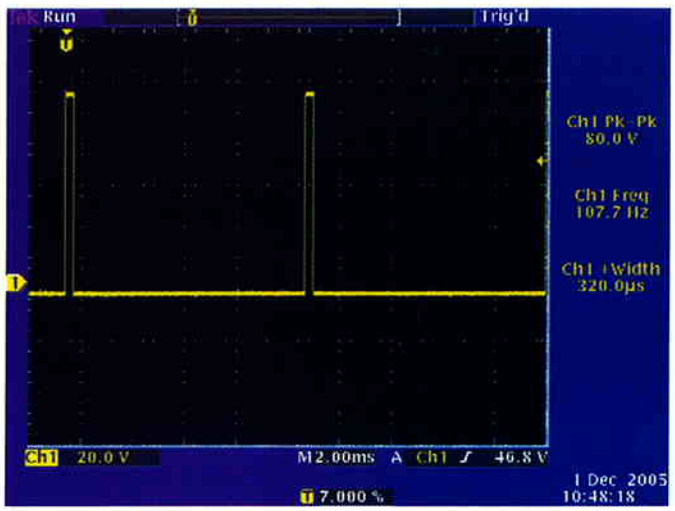
Circuit details

The full circuit for the TENS unit is shown in Fig.4. Power from the 9V battery comes via switch S1 and diode D6. D6 is included for reverse polarity protection but because we are running from batteries, we have specified a Schottky diode to minimise voltage losses.

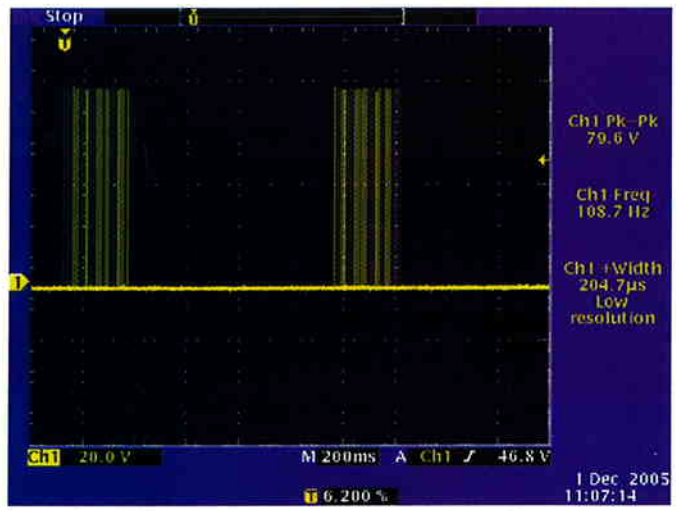
IC1 is the switchmode controller. It has a switching transistor at pin 1 and a feedback input at pin 5. Its frequency of oscillation is set by the 2.2nF capacitor at pin 3. The peak current through the primary winding of T1 is limited by the 0.22Ω resistor between pins 6 and 7 of IC1. In operation, the current through the primary winding of T1 is switched off when the voltage drop across the 0.22Ω resistor exceeds about 300mV.

Switching off the current through T1 causes voltage to be induced into T1's secondary when the primary field collapses. This charges two 470nF capacitors via diode D1. Voltage feedback from the 150kΩ resistor, VR1 and VR2 into pin 5 maintains the voltage at the desired setting up to 80V.

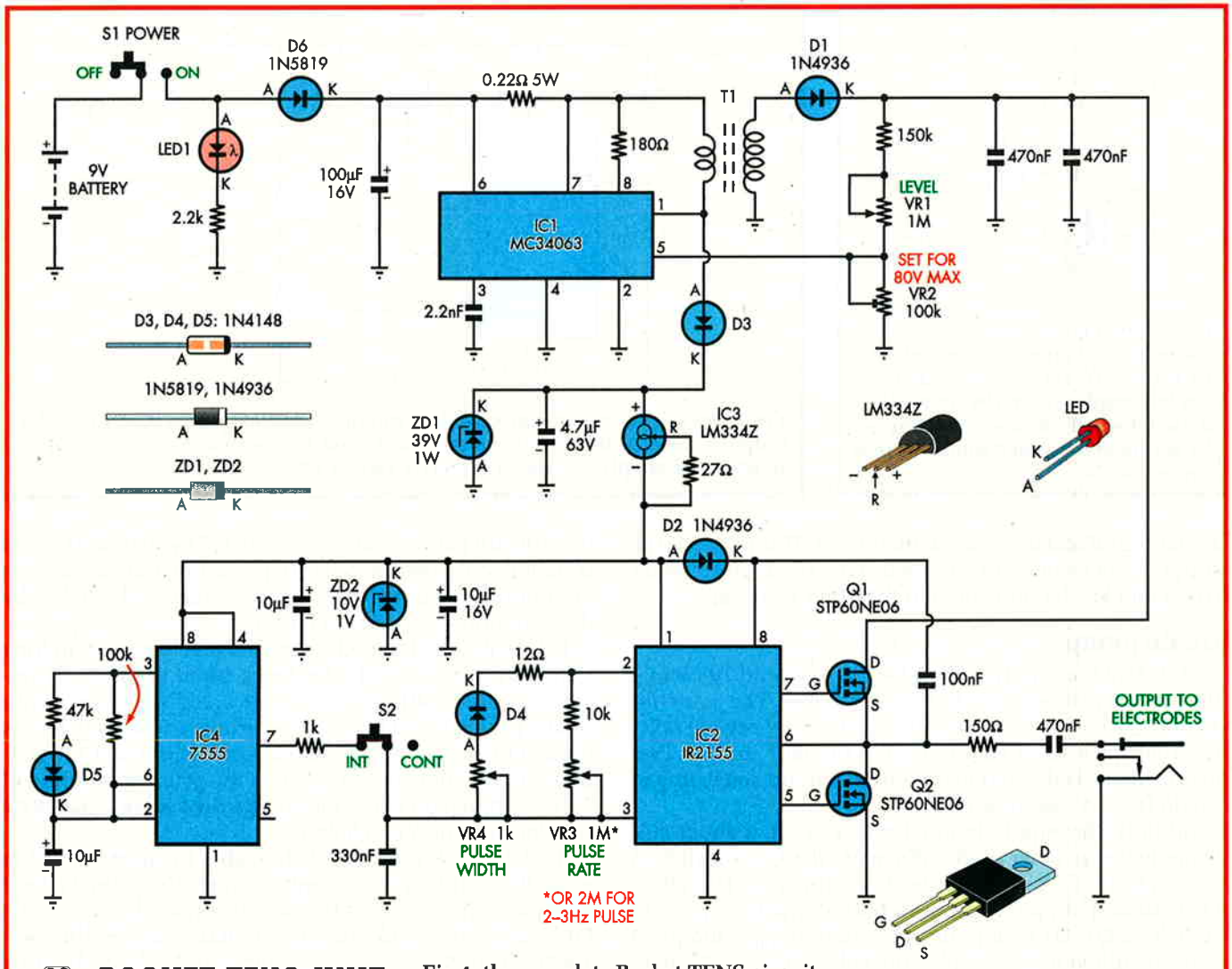
The circuit uses a transformer instead of a step-up inductor, as depicted in Fig.2. This is included to prevent high voltages occurring at pin 1 of IC1, where the maximum allowable voltage is 40V. Since we want up to 80V, the 2.59:1 step-up ratio between primary and secondary



Here are the pulses shown with a faster timebase. It shows the width of each pulse at about 320µs.



Finally, this is the intermittent pulse output showing the bursts of pulses at about 1.2Hz.



SC ©2005 POCKET TENS UNIT

Fig.4: the complete Pocket TENS circuit diagram. Its operation can be most easily understood by comparing it with the block diagram of Fig.1.

of T1 will ensure that the pin 1 voltage will be less than 40V. The primary winding can be used to provide a 10V supply for IC2 and IC4.

This supply is derived in two steps. First, diode D3 charges the associated 4.7µF capacitor. Voltage across it is limited to +39V by zener diode ZD1. Diode D3 also clamps the maximum voltage at pin 1 of IC1 to one diode drop above 39V.

IC2's power is then derived via an LM334Z constant current source, IC3.

The 27Ω resistor between the R and V- pins of IC3 sets the constant current to about 2mA. The current source supplies a 10V zener diode (ZD2) that regulates the supply voltage to 10V. This supply also powers IC4.

Note that we need to derive the supply for IC2 in this way because the 9V directly from the battery is just not enough for satisfactory operation. This is because IC2 has an internal voltage shutdown that operates at below 8.4V. IC2 will therefore not operate when its supply drops to this level.

If we were powering this IC directly from batteries, we would need at least 8.6V from the battery to ensure operation if we include the drop across diode D6.

This would give an extremely short operation time with a 9V battery. By contrast using the power supply system described

Specifications

Output Voltage	Adjustable from 12V to 80V
Pulse Rate	Adjustable from 4.6Hz to 410Hz
Pulse Width	Adjustable from between 70 and 320µs
Intermittent	24% duty cycle at 1.2Hz (220ms pulse burst with an 800ms off period)
Battery Drain	Typically less than 20mA (31mA at 80V output, 19mA at 50V output)
Battery	9V Alkaline (or a 9V NIMH rechargeable)
Battery Voltage	7.2V minimum for a 12V to 80V output range, 4V minimum for a 22V to 80V output range.

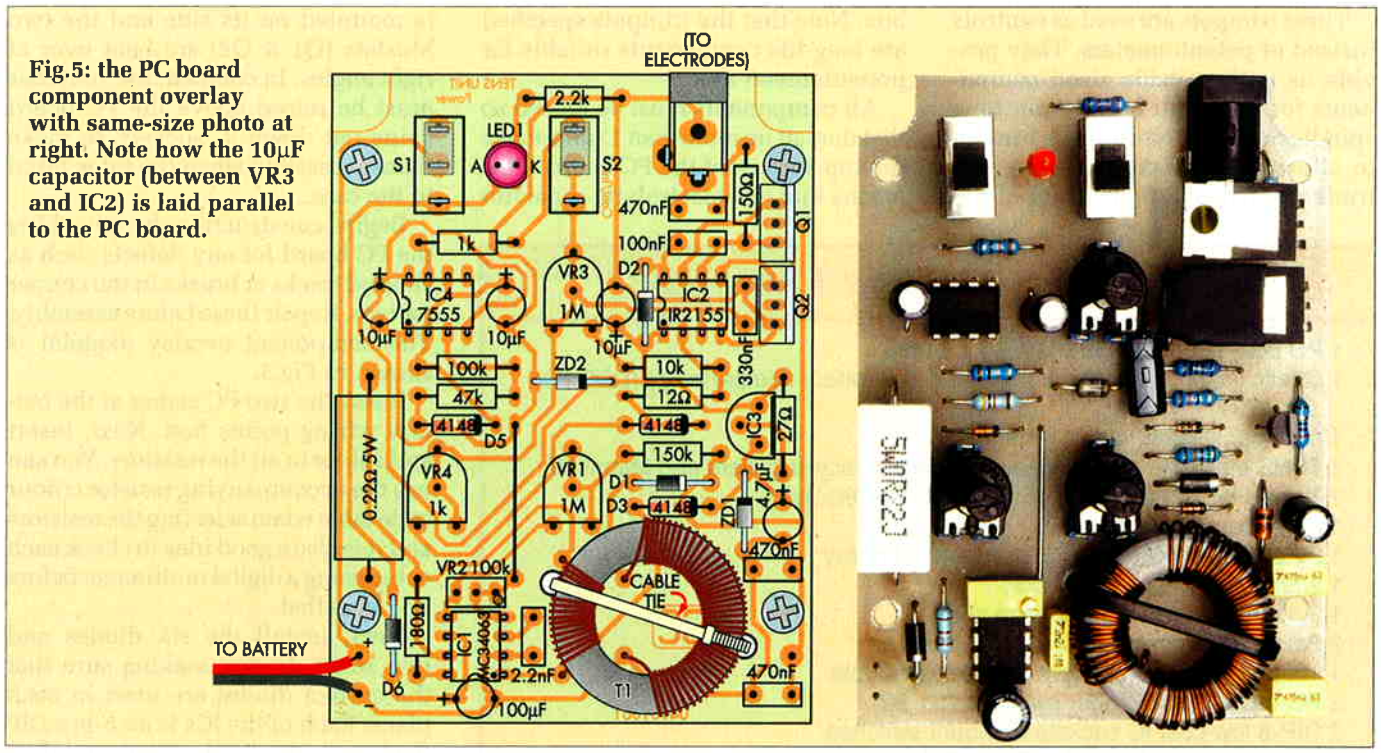


Fig.5: the PC board component overlay with same-size photo at right. Note how the 10µF capacitor (between VR3 and IC2) is laid parallel to the PC board.

above, the battery can be used down to at least 7.2V and in most cases down to 4V.

Q1 and Q2 are 200V Mosfets and are used to switch the high voltage on and off to produce the requisite output pulses on the electrodes. Q1 & Q2 constitute a totem pole output stage with Q1 turning on to charge the 470nF output capacitor via the series 150Ω resistor and the load resistance (which in this case is the patient). Each time Q1 turns off, Q2 turn turns on to discharge the capacitor via the series 150Ω resistor. The amount of time Q1 is switched on determines the pulse width of the voltage output. Q2's on time controls the pulse rate (ie, the frequency).

In more detail, Q2 is switched on for the time set by the 330nF capacitor at pin 3 and the resistance between pins 3 and 2 of IC2. VR3 adjusts this time between about 0.22 and 2.4ms, giving a pulse rate between 4.6Hz and 410Hz.

Q1 is switched on for the time duration set by potentiometer VR4, the series 12Ω resistor and diode D4. The pulse width ranges between 70µs and 320µs.

Intermittent mode

IC4 is a 7555 CMOS timer configured to provide the intermittent mode. It operates as a free running oscillator. The output at pin 3 is used to charge the 10µF capacitor at pins 2 & 6 via the 47kΩ resistor and diode D5 and discharge it via the parallel 100kΩ resistor. This gives a pulse waveform at pin 3 with an uneven duty cycle, with the pulses being high for 0.22s and low for 0.7 seconds.

We don't use the pin 3 output to modulate IC2. Instead, we use the capacitor discharge output at pin 7. This pin 7 output is an open drain Mosfet which is open circuit when pin 3 is high and conducts signal to ground when pin 3 is low.

Each time pin 7 of IC4 pulls low, it discharges the 330nF capacitor at pin 3 of IC2 to stop IC2 from oscillating. This prevents any output to the electrodes and provides an intermittent modulation for the electrode output.

Construction

The SILICON CHIP TENS unit is built onto a PC board coded 11101061 and measuring 85 x 64mm. It is housed in a plastic case measuring 134 x 69 x 23mm. An adhesive plastic label measuring 49 x 113mm is fitted to the lid of the case.

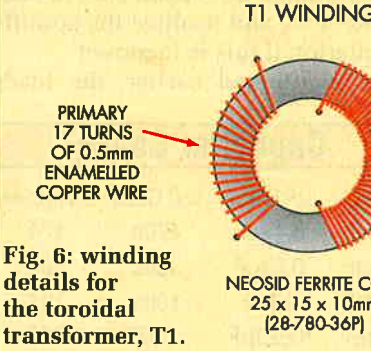


Fig. 6: winding details for the toroidal transformer, T1.

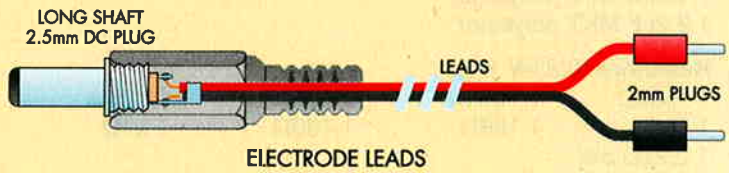


Fig. 7: here's how to wire the electrode leads, using a 2.5mm long shaft DC plug. The leads can be as long as you like, within reason!

Three trimpots are used as controls instead of potentiometers. They provide us with suitable sized components for the small box. 10mm long spindles are inserted into each trimpot to allow adjustment and these protrude through the front panel of the box. Note that the trimpots specified are long-life components suitable for potentiometer use.

All components must be placed so that they sit no more than 13mm above the top surface of the PC board. This means that one electrolytic capacitor is mounted on its side and the two Mosfets (Q1 & Q2) are bent over at right angles. In contrast, the switches must be raised above the PC board using cut down IC sockets, to make them accessible when the lid is fitted to the case.

Begin construction by checking the PC board for any defects such as shorted tracks or breaks in the copper pattern. Repair these before assembly. The component overlay diagram is shown in Fig.5.

Insert the two PC stakes at the battery wiring points first. Next, insert and solder in all the resistors. You can use the accompanying resistor colour code table when selecting the resistors and it is also a good idea to check each value using a digital multimeter before it is installed.

Next, install the six diodes and two zener diodes, making sure that the correct diodes are used in each place. Each of the ICs is an 8-pin DIP device, so don't mix them up when installing them.

The capacitors can be mounted next. The MKT polyester types have codes stamped on them to indicate their value and we have provided a table of the different codes. The electrolytic types must be oriented as shown and the 10µF capacitor adjacent to VR3 must be laid on its side.

The switches are mounted on cut-down IC sockets. The sockets are made by cutting up IC sockets into strips of five contacts using a sharp utility knife. The two unused pin contacts for each switch socket are removed. Insert and solder the sockets in place and then insert the switches.

The trimpots are soldered next, taking care to place the correct value of trimpot in each position. The 10mm spindles are inserted with the pointer facing the centre pin of the trimpot. Check that the rotation to the left and right is correct, with the pointer rotation the same from each side of centre. Remove and readjust the spindle orientation if this is incorrect.

As mentioned earlier, the leads

Parts List – Pocket TENS Unit

1 PC board coded 11101061, 85 x 64mm
1 plastic case, 134 x 69 x 23mm, with 9V battery compartment (DSE Cat ZA-4731)
1 front panel label, 49 x 113mm
1 TENS electrode set (available from pharmacy suppliers and chemists)
1 Neosid ferrite core, 25 x 15 x 10mm (28-780-36P)
1 9V battery clip lead
1 9V alkaline or 9V NiMH rechargeable battery
1 2.5mm PC-mount DC socket
1 2.5mm DC line plug with long shaft
2 2mm plugs for electrodes
1 1m length of figure-8 light duty flexible cable
2 PC-mount SPDT slider switches (S1,S2)
2 DIP-8 low-cost IC sockets to mount switches
3 15mm spindles for VR1, VR3 & VR4
2 200mm long cable ties
2 PC stakes
4 M3 x 6mm screws
1 2m length of 0.5mm enamelled copper wire
1 12mm length of 9.5mm heatshrink tubing
1 15mm length of 3.3mm heatshrink tubing

Semiconductors
1 MC34063 DC-DC converter (IC1)
1 IR2155 Mosfet driver (IC2)
1 LM334Z current source (IC3)
1 7555 CMOS timer (IC4)
2 STP6N60E N-channel Mosfets or similar rated at 200V 1A minimum (Q1,Q2)
1 39V 1W zener diode (ZD1)
1 10V 1W zener diode (ZD2)
2 1N4936, UF4004 fast diodes (D1,D2)
3 1N4148 switching diodes (D3-D5)
1 1N5819 Schottky 1A diode (D6)

Capacitors
1 100µF 16V PC electrolytic
3 10µF 16V PC electrolytic
1 4.7µF 63V PC electrolytic
3 470nF MKT polyester
1 330nF MKT polyester
1 100nF MKT polyester
1 2.2nF MKT polyester

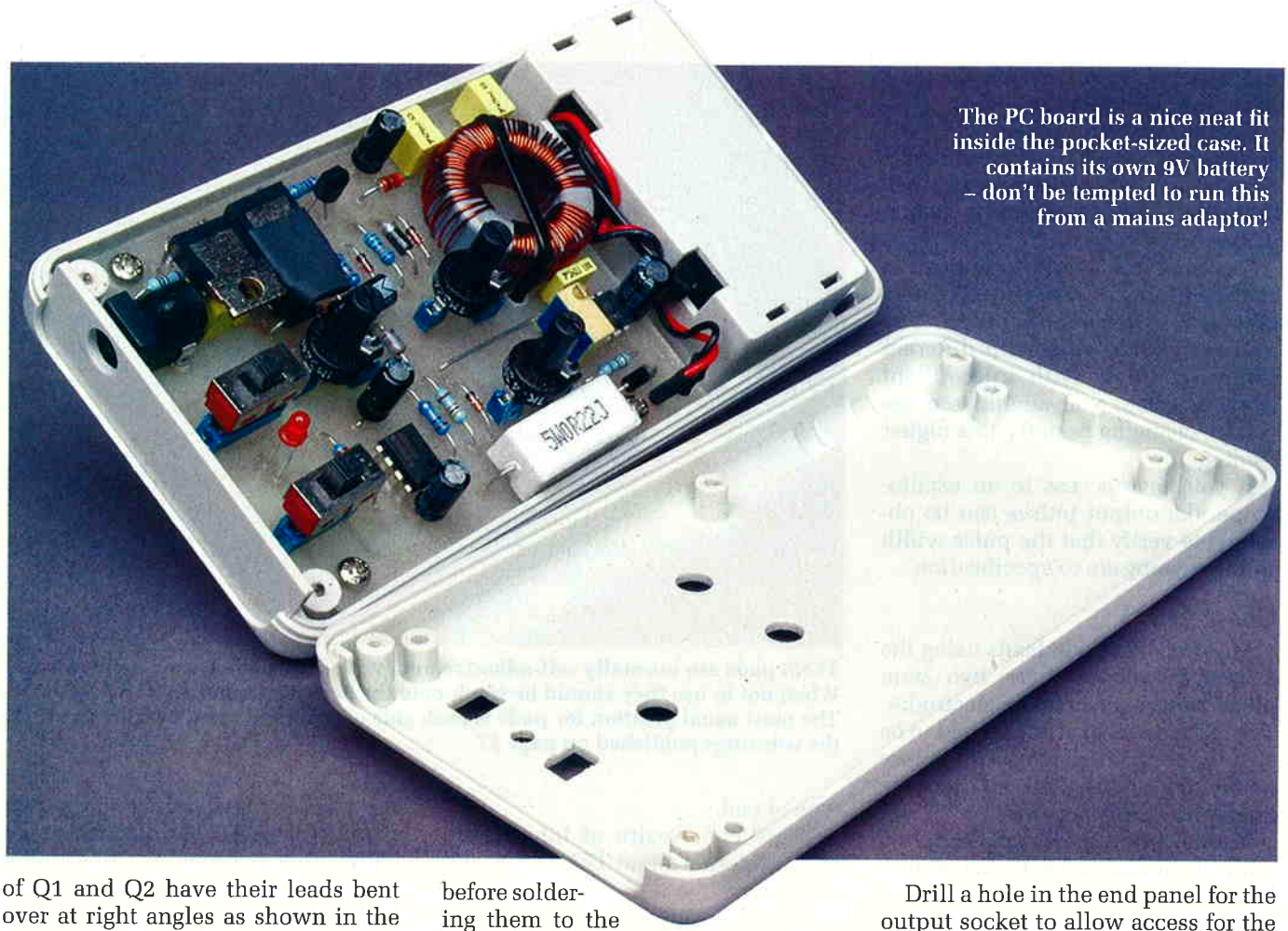
Resistors (0.25W 1%)

1 150kΩ	1 100kΩ	1 47kΩ	1 10kΩ	1 2.2kΩ
1 1kΩ	1 180Ω	1 150Ω	1 27Ω	1 12Ω

1 0.22Ω 5W
2 1MΩ horizontal trimpot (Piher PT10MV10 105A 202E) (VR1,VR3) (OR 2MΩ for VR3 for a 2.3Hz minimum rate) (Farnell 868-437 for 1MΩ)
1 100kΩ multiturn top adjust trimpot (VR2)
1 1kΩ horizontal trimpot (Piher PT10MV10 102A 202E) (VR4) (Farnell 868-383)

Capacitor Codes

Value	µF Code	IEC Code	EIA Code
470nF	0.47µF	470n	474
330nF	0.33µF	330n	334
100nF	0.1µF	100n	104
2.2nF	.0022µF	2n2	222



The PC board is a nice neat fit inside the pocket-sized case. It contains its own 9V battery – don't be tempted to run this from a mains adaptor!

of Q1 and Q2 have their leads bent over at right angles as shown in the photograph above. They must lie over the adjacent components so that their bodies are no higher than 13mm above the PC board.

Fig.6 shows the winding details for the toroidal transformer T1. It is wound with 0.5mm enamelled copper wire. It is important to get the winding direction and number of turns correct.

Start by winding on 44 turns for the secondary in the direction shown. The primary is also wound in the direction shown, with 17 turns. Strip the enamel insulation from the wire ends before soldering them to the PC pads. Then secure the finished toroid to the PC board with a cable tie, as shown.

Indicator LED1 is mounted with the top of its lens 15mm above the PC board. Make sure its orientation is correct. Attach the PC board to the base of the case with the four M3 screws directly into the integral standoffs in the case.

The front panel label can be attached to the lid of the case and the holes drilled and filed to shape for the two slide switches, the 3mm LED and the three trimpot spindles.

Resistor Colour Codes

	No.	Value	4-band Code (1%)	5-band Code (1%)
❑	1	150kΩ	brown green yellow brown	brown green black orange brown
❑	1	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	1	2.2kΩ	red red red brown	red red black brown brown
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	1	180Ω	brown grey brown brown	brown grey black black brown
❑	1	150Ω	brown green brown brown	brown green black black brown
❑	1	27Ω	red violet black brown	red violet black gold brown
❑	1	12Ω	brown red black brown	brown red black gold brown

Drill a hole in the end panel for the output socket to allow access for the DC plug.

The battery clip wires are fed through from the battery compartment side via the holes in the box. Secure these wires with a cable tie and solder them to the PC stakes using heatshrink tubing (the small diameter length cut in half) to cover the PC stakes and wire. Mosfet Q2 also has its tab covered in heatshrink tubing to avoid its tab shorting to the tab of Q1.

Testing

Fit the battery and plug in the DC socket with the backing piece removed. Connect a multimeter (set to the 200V DC range) between the outside terminal of the plug (-) and the tab of Q1.

Switch on power and check that LED1 lights and that there is a voltage reading. Set the voltage pot VR1 fully clockwise and adjust trimpot VR2 for a reading of +80V.

If you are not able to obtain the correct voltage, check that the transformer is wound correctly. In particular, check the winding directions for each winding.

Check that the voltage at pin 1 of IC2 is around +10VDC. Set the pulse

width pot VR4 fully clockwise and select the continuous mode.

Connect your multimeter set for AC volts across the DC socket terminals. You should measure about +18V AC, indicating that switching is taking place.

Note that this is only an indication of the output, as some multimeters may give different readings. The readings should alter with different control settings. With intermittent mode selected, you should see the voltage changing from 0V to a higher reading.

If you have access to an oscilloscope, the output pulses can be observed to verify that the pulse width and frequency are to specification.

Using TENS

Make up electrode leads using the 2.5mm DC plug and the two 2mm plugs. Now connect to the electrodes. The electrode sockets may need to be slightly crimped with pliers to close up the socket hole. This will hold the 2mm plugs more securely.

The electrodes are usually supplied with an adhesive back that allows them to be easily attached to the skin. If the adhesive dries out, a smear of personal lubricant will be helpful.

The electrodes can then be attached to the skin using any of the variety of tapes or bandages used to secure wound dressings. Attach the electrodes in position on either side of the pain source. (A useful chart showing typical TENS pad locations may be found at **www.vitalityweb.com/backstore/tensplacement.htm)**

Before switching on the TENS unit be sure that the output voltage is turned down to the minimum.

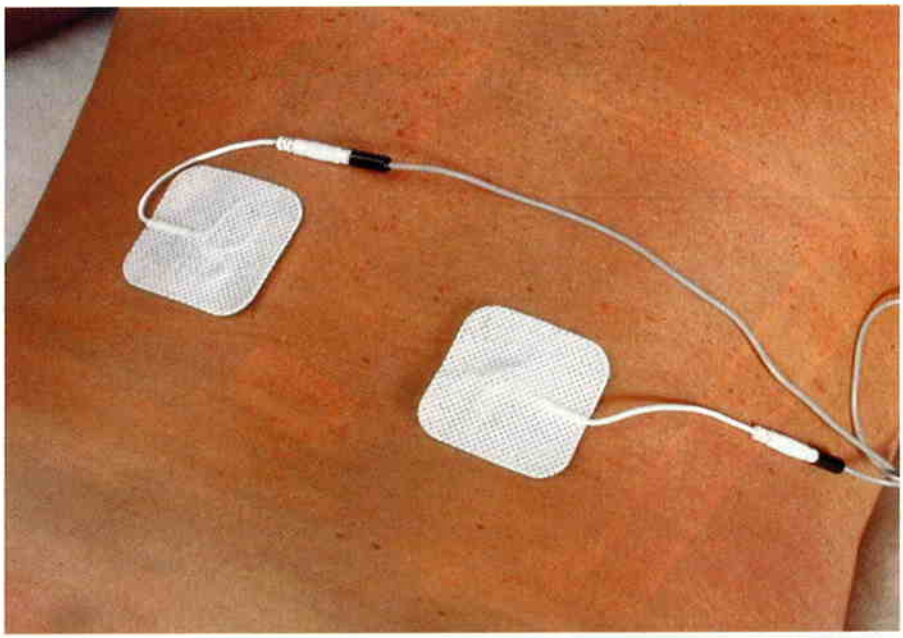
Wind the voltage up until a tingling sensation can be felt and adjust the pulse rate and width for the desired effect. The voltage will need to be wound up during the period of treatment to compensate for the body's adaptation to the stimulation.

The intermittent selection is used where the treatment period is long (normal treatment sessions are typically for 20 minutes) or where the user finds the continuous effect to be waning.

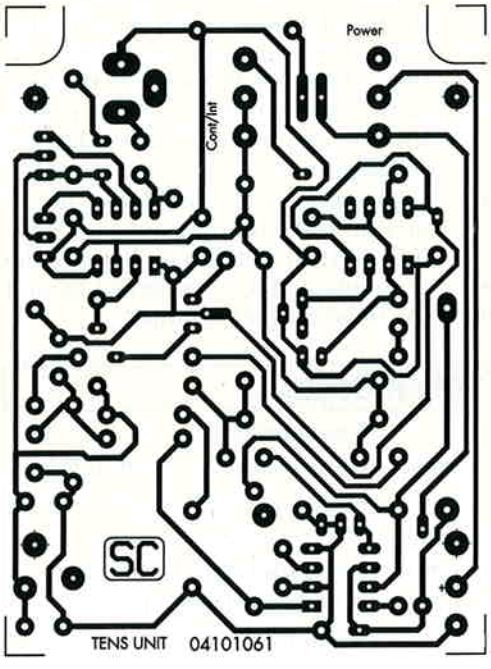
It is possible that the TENS pads will irritate the skin, not (usually) so much from the TENS itself but the adhesive used on the pads. If so, we suggest trying a different brand or type of pad.

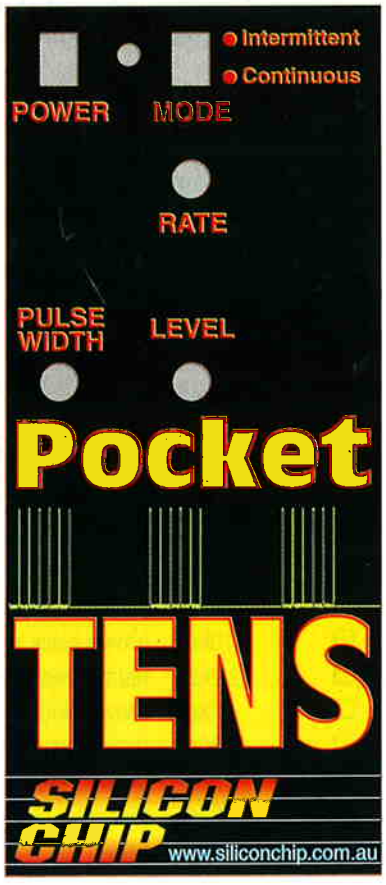
There is a wealth of information on the internet about TENs units and their use.

Like any treatment regimen, we suggest you ask your General Practitioner for advice before commencing treatment with the TENS unit. Remember, TENS does not treat any underlying condition; it merely masks the pain and makes it more bearable. **SC**



TENS pads are normally self-adhesive and, with care, can be used many times. When not in use they should be stuck onto the backing sheet they came with. The most usual position for pads is each side of a painful area, bearing in mind the warnings published on page 17.





Figs 8 & 9: same-size artwork for the PC board and front panel. A photocopy of the front panel can also be used as a drilling template for the case.

Announcing the Inaugural 2006 SILICON CHIP Excellence in Education Technology Awards

SILICON CHIP magazine aims to promote the education, development and application of electronic technology in all fields throughout Australia. As part of that aim, we are announcing the SILICON CHIP Excellence in Education Technology awards, with a prize pool of $10,000. The inaugural awards will be announced in the December 2006 issue of SILICON CHIP.

Separate awards will be made to students of secondary schools throughout Australia and to students of universities and TAFE colleges throughout Australia.

The secondary school awards will have three categories:

(a) Best final year assignment of an individual student involving electronics technology

(b) An award to the school sponsoring the winning individual student

(c) Best school project involving electronics technology

The university and TAFE college awards will have three categories:

(a) Best project from a student as part completion of a degree, diploma or certificate in electronics or a related field (ie, mechatronics)

(b) Best research project from a post-graduate student working in an area of applied electronics

(c) An award to the university faculty or school sponsoring the best research project.

Entries and judging

The awards will be judged by the editorial staff of SILICON CHIP, convened as a judges panel. The decisions of the judges will be final.

Entries for the 2006 awards will open 1st May 2006, with final submissions to be made by September 30th, 2006. All submissions will be confidential, until the winners are announced, in the December 2006 issue of SILICON CHIP.

Each award will take the form of a cash prize and a commemorative plaque. All enquiries about these awards should be directed to the editor via email to:

awards@siliconchip.com.au

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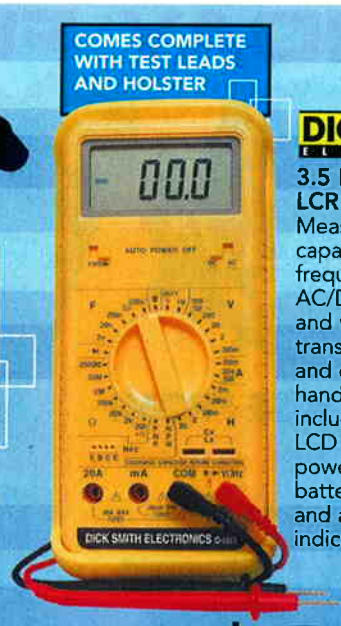

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3.5 Digit LCR Multimeter
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Jan 2006

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This CCTV surveillance system includes a high quality CMOS camera, is capable of connecting 2 cameras simultaneously and features a built-in microphone, infrared LEDs for night vision and easy RCA connectivity. Includes 1 camera, 18m lead and a high resolution 5" SecuraView B&W monitor. L 5863

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NB. Colour of soldering iron may vary.

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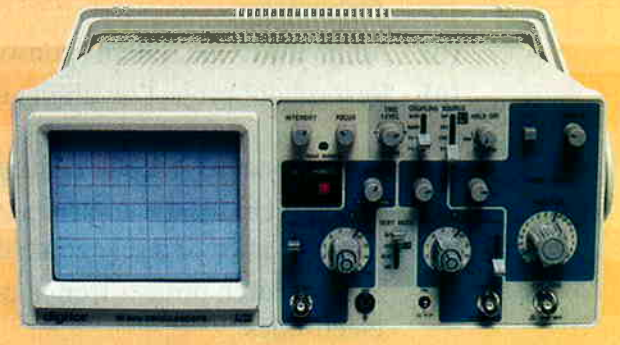

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This 20MHz bandwidth Oscilloscope suits a wide range of applications. Dual trace, dual trigger with fully adjustable sweep time (23 steps), variable hold-off, fully adjustable sensitivity, switch selectable X-Y operation, selectable trigger modes, AC, TV-H and TV-V trigger coupling, front panel variable trace rotation sweep rate from 0.1uS/div to 2 sec/div. Complete with two 60MHz CRO probes. Q 1802

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NB. Front panel may differ from that shown above.

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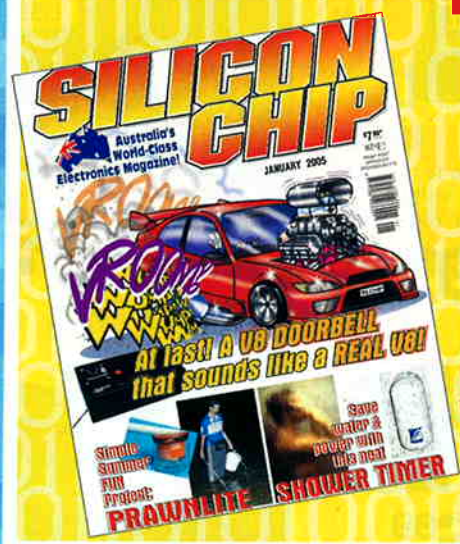

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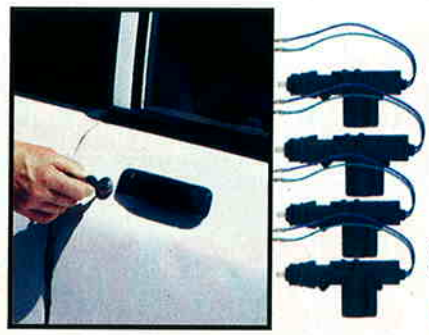

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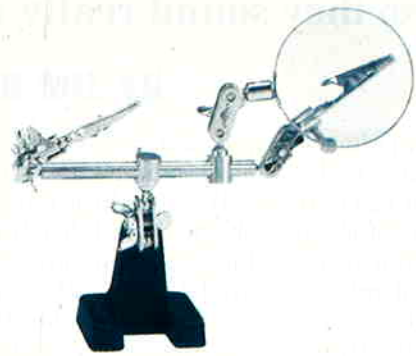

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Little Jim AM Transmitter

Dubbed "Little Jim", this low-power "baby" AM radio transmitter has a range of just a few metres, to keep it nice and legal. It's ideal for sending the output of your MP3 player or personal CD player to your car radio, or for feeding recordings of vintage radio shows to vintage radios, so they sound really authentic.

By JIM ROWE

WHY WOULD YOU want a broadcast band AM transmitter with a power output so low that it can only be received inside a radius of about four metres? Well, let's say you've just finished building a replica of a classic 1940s' era AM radio, which you're entering into a club competition. Wouldn't it be great if you could tune it into an "authentic" old time radio program, to recreate the way it might have sounded back then?

With this little transmitter you'll be able to do just that, by rebroadcasting historic radio programs like those available on CD from Screensound Australia (see sidebar).

Alternatively, you might want to play the music from your personal MP3 or CD player through your car radio when you're driving to and from work – but the radio lacks direct audio inputs. With this little transmitter, that's no problem – although you will need to modify it slightly so that it runs from the 12V car battery.

In short, the whole idea of this project is allow any line-level audio signal to modulate an RF carrier in the AM broadcast band, so that it can be

Unit For cast Band

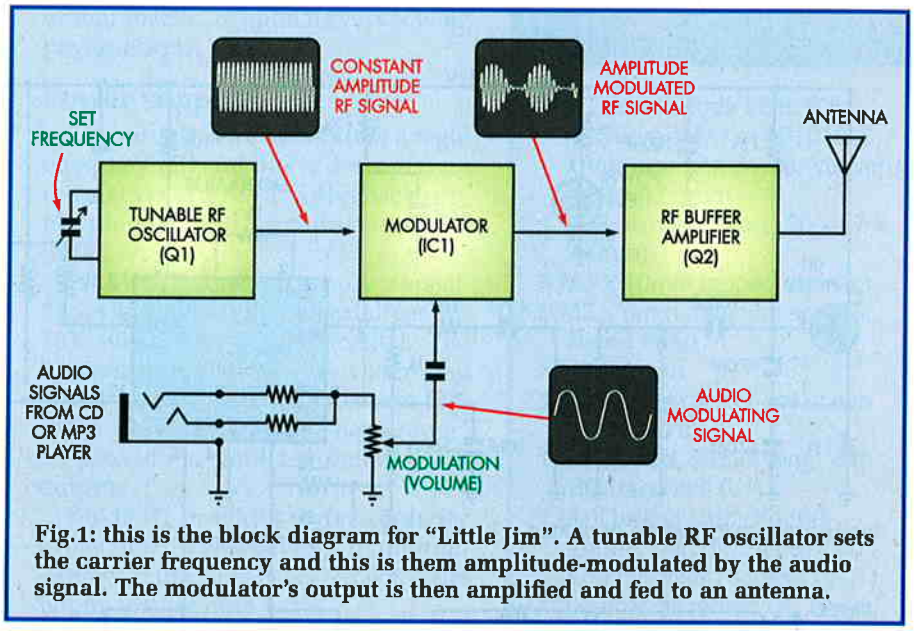


Fig.1: this is the block diagram for "Little Jim". A tunable RF oscillator sets the carrier frequency and this is them amplitude-modulated by the audio signal. The modulator's output is then amplified and fed to an antenna.

played through a nearby conventional AM radio.

The carrier frequency of the transmitter can be tuned to virtually anywhere in the lower half of the broadcast band – ie, from 550kHz to about 980kHz. This allows you to choose a frequency that's away from any of the broadcasting stations operating in your area, to ensure interference-free reception.

The audio quality from the transmitter's signal is very close to that of the program material you feed into it, because it uses a special balanced modulator IC. There's also a modulation level control, so you can easily adjust the transmitter for the best balance between audio volume and minimum distortion.

But the best part is that the whole transmitter uses just a handful of parts (including two transistors and the modulator IC) and fits inside a standard UB3 sized plastic jiffy box. It's also low in cost and easy to build, as all the parts fit on a small PC board. And it's run from either a plugpack power supply or a 12V battery, so safety isn't a problem, even for beginners.

How it works

Although it's extremely simple and designed for very low output power, "Little Jim" uses exactly the same "building blocks" as a full-sized AM radio transmitter. Fig.1 shows the details – it consists of an RF (radio frequency) oscillator, a modulator and an RF output amplifier or "buffer".

The job of the RF oscillator is to generate a continuous sinewave signal of constant amplitude and with a frequency in the range from 550-1650kHz – ie, in the AM broadcast band. This provides the transmitter's "RF carrier", which is the frequency you tune to with your AM radio to receive the signal.

In most full-size AM transmitters, the RF oscillator uses a quartz crystal and is fixed in frequency, so the station concerned is always found at exactly the same place on your radio's tuning dial. However, in this case, the oscillator is tunable over the range from 550kHz to about 980kHz, so you can set the transmitter's frequency to a part of the band that's currently unoccupied in your area, for clear reception.

The signal produced by the RF oscillator is fed into the modulator, which is the "heart" of the transmitter. As shown in Fig.1, this also receives the audio signals from your MP3 or CD player. In this case, the stereo signals from the player are fed in via a simple mixing circuit, to convert the signals into mono. The resulting mono signal is then fed to the modulator via a modulation (volume) control, which sets the modulation level.

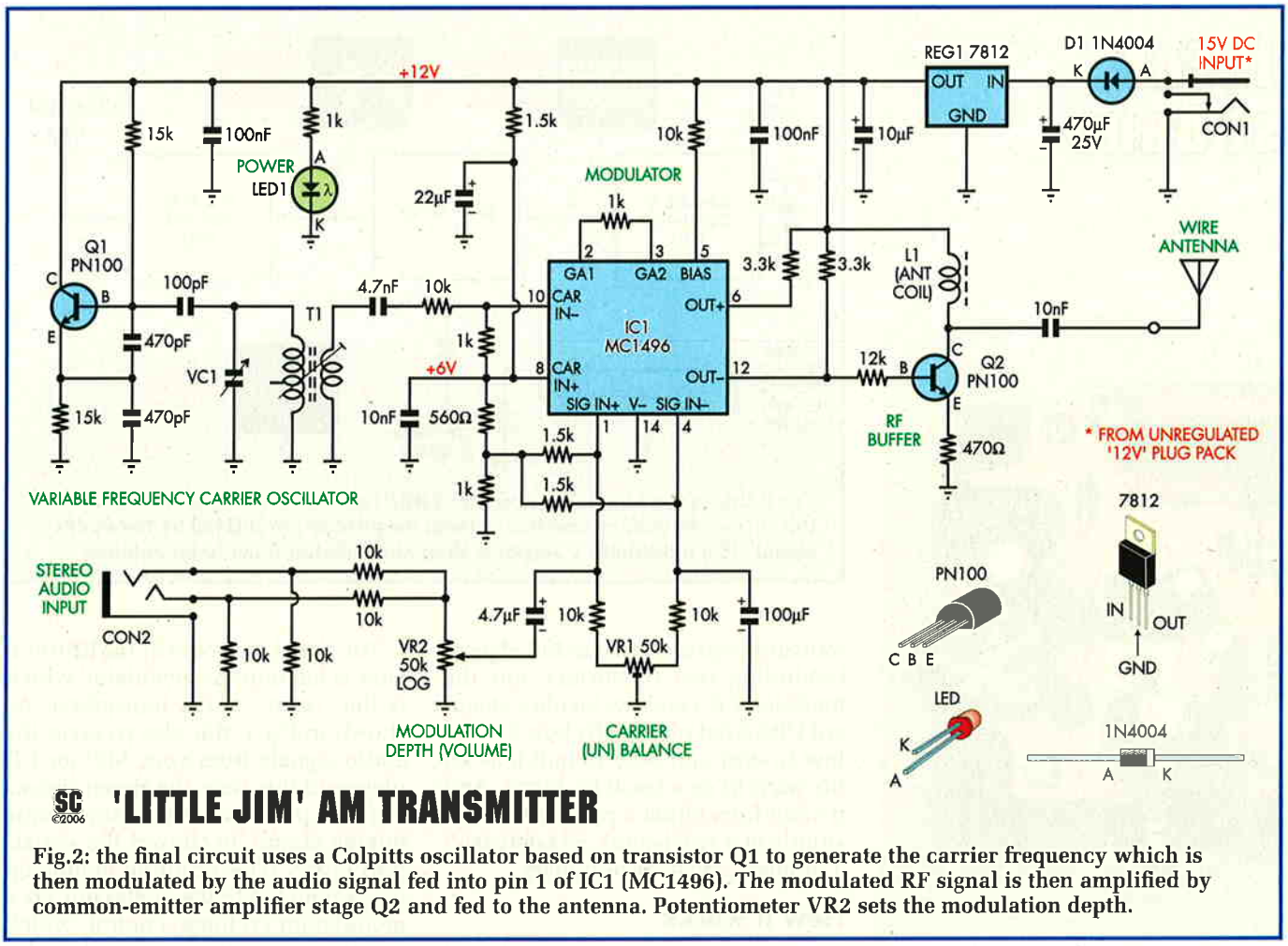
In operation, the modulator uses the audio signal to vary the amplitude of the RF signal (ie, it varies the amplitude of the carrier). When the audio signal swings positive, the amplitude

Keeping It Legal

The AM transmitter described in this article has very low RF power output (a tiny fraction of a watt) and is designed to have a range of no more than about four metres.

Do not attempt to modify the circuit with the aim of increasing its power output or to increase its range by feeding its output into a much larger antenna, because this would greatly increase the risk of interfering with the reception of licensed broadcasting stations.

It would also make you liable to prosecution by the broadcasting and spectrum management authorities and probable confiscation of your equipment as well.



'LITTLE JIM' AM TRANSMITTER

Fig.2: the final circuit uses a Colpitts oscillator based on transistor Q1 to generate the carrier frequency which is then modulated by the audio signal fed into pin 1 of IC1 (MC1496). The modulated RF signal is then amplified by common-emitter amplifier stage Q2 and fed to the antenna. Potentiometer VR2 sets the modulation depth.

of the carrier is increased and when it swings negative, the carrier's amplitude is reduced.

As a result the RF output signal from the modulator is varied up and down in amplitude, directly in step with the audio signals. In other words, the RF carrier is "amplitude modulated". The waveforms in Fig.1 show the basic idea.

Amplitude modulation or "AM" is just one way of using an RF signal to carry audio or other kinds of information from one place to another. Another approach is to frequency modulate the carrier and this transmission standard is called "FM" (for frequency modulation).

The amplitude-modulated RF output from the modulator is very weak, so before it can be fed to our transmitting antenna (which is just a short length of wire) we have to increase its level slightly by passing it through the third building block: the RF buffer amplifier. This stage amplifies the modulated RF signal to a level that's just high enough to cause weak radio signals to be radiated from the antenna.

Circuit details

OK, so that's the basic operational details of the transmitter. Now let's take a look at the circuit diagram – see Fig.2

The RF oscillator (which generates the carrier signal) is a simple Colpitts circuit, based on transistor Q1. This uses the primary winding of RF transformer T1 as the inductive arm of its resonant circuit, along with fixed 470pF and 100pF capacitors and a miniature tuning capacitor (VC1). T1 is a miniature local oscillator coil from a low-cost AM receiver coil kit.

The output of the oscillator is taken from the secondary winding of T1. This is then fed through a 4.7nF DC blocking capacitor and a series 10kΩ resistor to one of the two carrier inputs (pin 10) of IC1, an MC1496 balanced modulator specially designed for this kind of use.

The second carrier input of IC1 is pin 8 and is tied to ground potential as far as RF signals are concerned using a 10nF capacitor. However, the IC needs both its carrier inputs held at a DC bias level of about +6V and that's the purpose of the voltage divider network involving the 1.5kΩ, 560Ω and 1kΩ resistors between +12V and ground.

The 1kΩ resistor between pins 8 and 10 ensures that both carrier inputs are biased at the +6V level. It also forms a voltage divider with the 10kΩ resistor from T1, to reduce the unmodulated carrier level at IC1's inputs to below 60mV RMS – the maximum level which can be applied to its carrier inputs for undistorted output.

IC1's audio modulating signal inputs are at pins 1 and 4 and these have to be biased lower than the carrier inputs, to about +4V DC. This voltage is provided across the lowest 1kΩ resistor in the main bias divider and fed to the two audio inputs (pins 1 & 4) via two 1.5kΩ resistors. In addition,

the audio inputs are connected via 10kΩ resistors to trimpot VR1, which allows fine adjustment of their relative bias – and hence the modulator IC's operation.

The stereo audio input signal is fed into the unit via jack socket CON2 and mixed together via two 10kΩ resistors to form a mono signal. This signal is then fed to modulation depth control VR2.

In addition, two 10kΩ resistors have been connected between the audio inputs of CON2 and ground. These are used to provide suitable loads for your CD or MP3 player line/headphone outputs. If your particular player needs loads of less than 10kΩ, these two resistors can be reduced in value.

As shown in Fig.2, the modulating signal from VR2 is fed to just one of the modulator's audio input pins – in this case, to pin 1 via a 4.7µF DC blocking capacitor. The second input (pin 4) is tied to ground via a 100µF capacitor, so the full audio (AC) voltage from VR2 is effectively applied between the two input pins.

The 1kΩ resistor connected between pins 2 & 3 of IC1 is used to set the internal gain of the modulator, while the 10kΩ resistor from pin 5 to +12V sets the IC's internal bias and operating current level.

Modulated carrier outputs

The modulated carrier outputs from IC1 appear at pins 6 & 12, which are both connected to the +12V rail via 3.3kΩ load resistors. In this circuit, we only use the output from pin 12 and this drives the base of RF amplifier transistor Q2 via a 12kΩ resistor. Transistor Q2 is connected as a simple common-emitter amplifier stage, with an unbypassed emitter resistor to ensure low gain and stability. Its amplified output is developed across the collector load formed by L1, a broadcast-band antenna coil wound on a very small ferrite rod.

As well as forming Q2's collector load, L1 actually forms part of the transmitter's antenna, because the ferrite rod inevitably radiates some RF energy. However, its very small size makes it a rather poor radiator, so an external wire antenna (about two metres long) is also connected to Q2's collector via a 10nF coupling capacitor.

This "dual antenna" system gives the transmitter a range of about three or four metres, despite its very low RF power output.

Power supply

The circuit is powered from a regulated 12V rail and this is derived from the mains via a 12V DC plugpack supply, diode D1 and 3-terminal regulator REG1.

A 12V DC plugpack supply is specified, since these typically deliver 15-16V when only lightly loaded. The transmitter circuitry draws less than 40mA in operation, which means that REG1 has quite enough "head room" to provide a well-regulated +12V output.

Diode D1 provides reverse polarity protection, to prevent the circuit from damage if the supply is connected the wrong way around.

Alternatively, for use in situations where no mains power is available, the transmitter can be powered from a 12V battery (eg, a car battery). This involves removing REG1 and replacing it with a wire link between its input and output connection pads. More about this later.

Finally, LED1 is used to provide power-on indication. It's connected across the 12V supply in series with a 1kΩ current-limiting resistor. (ie, the current through the LED is 10mA).

Construction

Construction is easy, with all the parts mounted on a small PC board measuring 122 x 57.5mm. This board has cutouts in each corner, so it can fit snugly inside a standard UB3 size jiffy box.

Note that there are actually two slightly different versions of the PC board, to suit the two different 3.5mm stereo jacks sold by kit suppliers. The board coded 06101061 suits the jack sold by Dick Smith Electronics, while the version coded 06101062 suits the jack sold by both Jaycar Electronics and Altronics.

There are no other differences – apart from the provisions for mounting the different 3.5mm jacks (CON2), both board versions are identical.

Fig.3 shows the assembly details. Begin the by fitting the PC board terminal pin for the antenna wire connection, located just to the right of the antenna rod, then fit DC input connector CON1 and the audio input jack CON2.

That done, you can install the resistors. These are not polarised, so you can fit them either way around although it's best to have their colour codes all running in the same direc-

Parts List

1 PC board, code 06101061 (DSE version) or 06101062 (Altronics and Jaycar versions), 122 x 57.5mm
1 UB3-size jiffy box (130 x 67 x 44mm)
4 M3 x 10mm tapped spacers
9 M3 x 6mm machine screws, round head
1 M3 hex nut
1 mini RF oscillator coil in can (T1 – red slug)
1 Ferrite rod, 55mm long, with BC band coil (L1)
1 Mini tuning capacitor 60-160pF, with disc-type knob and mounting screws (VC1)
1 2.5mm concentric DC socket, PC-mount (CON1)
1 3.5mm stereo jack, PC-mount (CON2)
1 mini control knob (to suit VR2)
2 cable ties, 100mm
1 PC terminal pin, 1mm diameter
1 2m length of insulated hookup wire
1 50kΩ horizontal trimpot (VR1)
1 50kΩ log pot, 16mm PC-mount (VR2)

Semiconductors

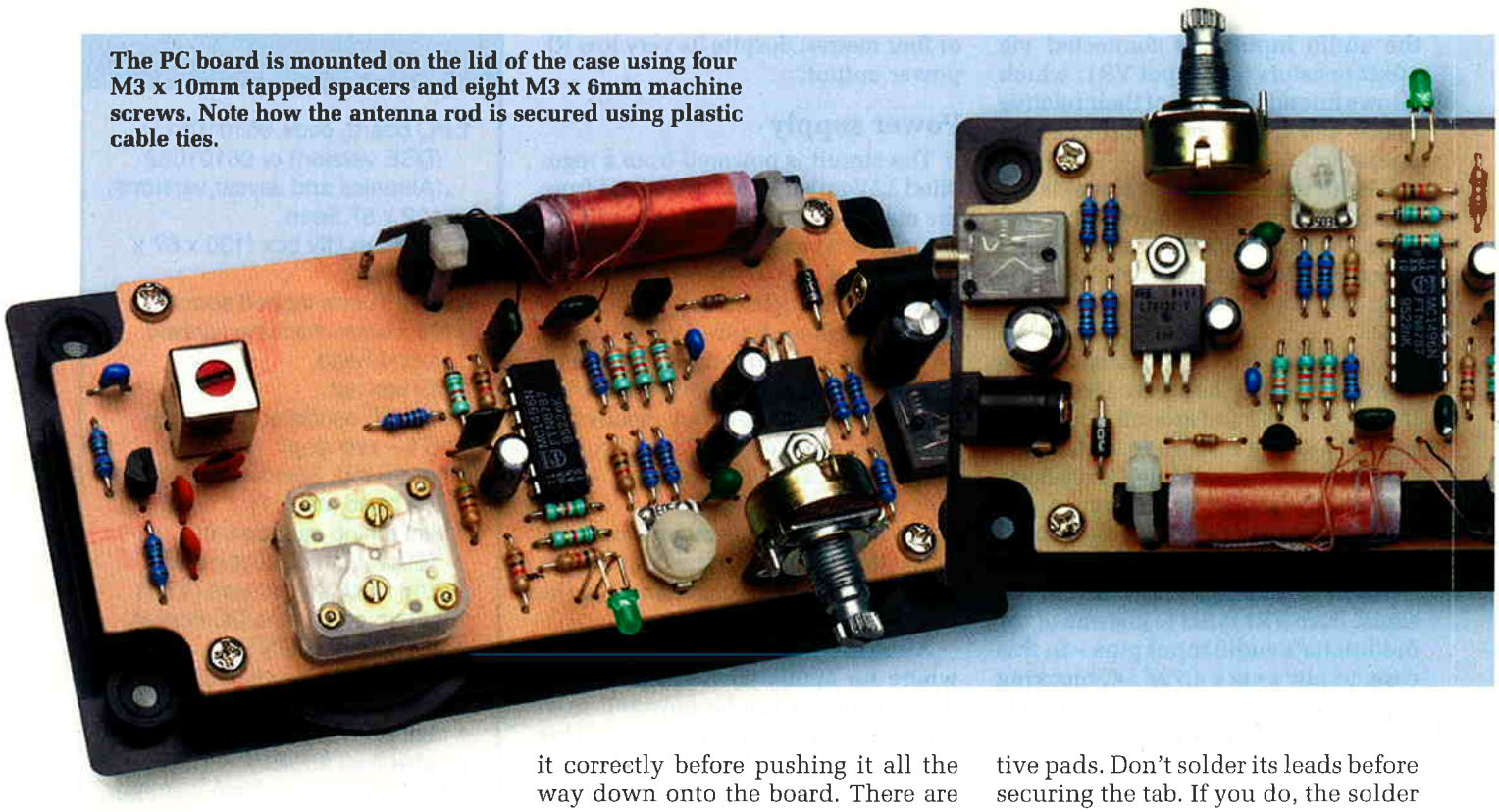
1 MC1496 balanced modulator (IC1)
1 7812 +12V regulator (REG1)
2 PN100 NPN transistor (Q1,Q2)
1 3mm green LED (LED1)
1 1N4004 silicon diode (D1)

Capacitors

1 220µF 25V RB electrolytic
1 100µF 16V RB electrolytic
1 22µF 16V RB electrolytic
1 10µF 16V RB electrolytic
1 4.7µF 16V tantalum
2 100nF monolithic
1 10nF metallised polyester
1 4.7nF metallised polyester
2 470pF NPO disc ceramic
1 100pF NPO disc ceramic

Resistors (0.25W 1%)

2 15kΩ	3 1.5kΩ
1 12kΩ	4 1kΩ
8 10kΩ	1 560Ω
2 3.3kΩ	1 470Ω



The PC board is mounted on the lid of the case using four M3 x 10mm tapped spacers and eight M3 x 6mm machine screws. Note how the antenna rod is secured using plastic cable ties.

tion to aid checking later on. Table 2 shows the resistor colour codes but you should also check each unit with a digital multimeter before installing it, just to make sure.

The non-polarised ceramic, monolithic and metallised polyester capacitors can go in next. Again, these can again go either way around but be sure to fit the correct value in each position. Once they're in, install the larger polarised capacitors. These include the 4.7µF tantalum unit which goes just below VR2 and the four RB electrolytics. Note that these must all be fitted with the correct polarity, as shown on the layout diagram.

The final capacitor to fit is tuning capacitor VC1. This fits on the top of the board, with its spindle stub shaft and three connection tabs passing down through matching holes in the board. The board is then turned over and the capacitor body attached to the board using two of the M2.5 x 4mm screws supplied with it. Don't lose the third screw, though – you'll need it later to attach the disc knob to VC1's spindle. Now solder VC1's three connection tabs to their board pads.

The oscillator coil T1 is next on the list. This is effectively polarised, because there are three connection pins on one side of its base and only two on the other – be sure to orient it correctly before pushing it all the way down onto the board. There are seven solder connections to make in all – five pin connections plus two for the can lugs.

Trimpot VR1 and modulation control pot VR2 can now go in, after which you can fit the semiconductors – diode D1, transistors Q1 and Q2, IC1 and LED1. These parts are all polarised so be sure to install them as shown in Fig.3.

LED1 should initially be installed with its body about 20mm above the board (this can be done by sliding a 20mm-wide cardboard spacer between its leads and pushing the LED down onto this spacer). Its leads should then be bent down through 90° at a point about 14mm above the board, so that the LED faces away from the board and will later protrude through a matching hole in the side of the case during final assembly.

Mains or battery power

If you intend running the transmitter from a mains plugpack, install regulator REG1 in the position indicated. As shown in Fig.3, this is mounted horizontally on the board, with its metal tab secured by an M3 x 6mm machine screw and nut.

To do this, first bend its leads down by 90° at a point 6mm from its body, then fit it to the board and secure its tab using the screw and nut. That done, its leads can be soldered to their respective pads. Don't solder its leads before securing the tab. If you do, the solder joints could fracture due to stress as the screw is tightened.

Alternatively, if you intend running the transmitter from a 12V battery, REG1 is left out and a small wire link fitted instead. This link should be fashioned from a short piece of tinned copper wire (or a resistor lead offcut), bent in an inverted-U shape with its centre section just over 5mm long. This is then fitted between the two outer connection lead holes for REG1 and soldered to the pads underneath.

Antenna rod & coil

The final component to fit to the transmitter board is the antenna rod and coil assembly (L1). This is secured using two small cable ties, each of which loops around under the board through the pairs of 3mm holes provided for this purpose.

(Note: do not replace the cable ties with wire or any other metal bands. A metal loop would form a "shorted turn" and this would absorb RF energy and seriously degrade the performance).

Unfortunately, making the coil's connections to the board can be a bit tricky. In most cases, there are four leads and it's not easy to work out which are the correct two to use – ie, the actual start and finish of the coil.

In fact, the only reliable way to identify the start and finish leads is

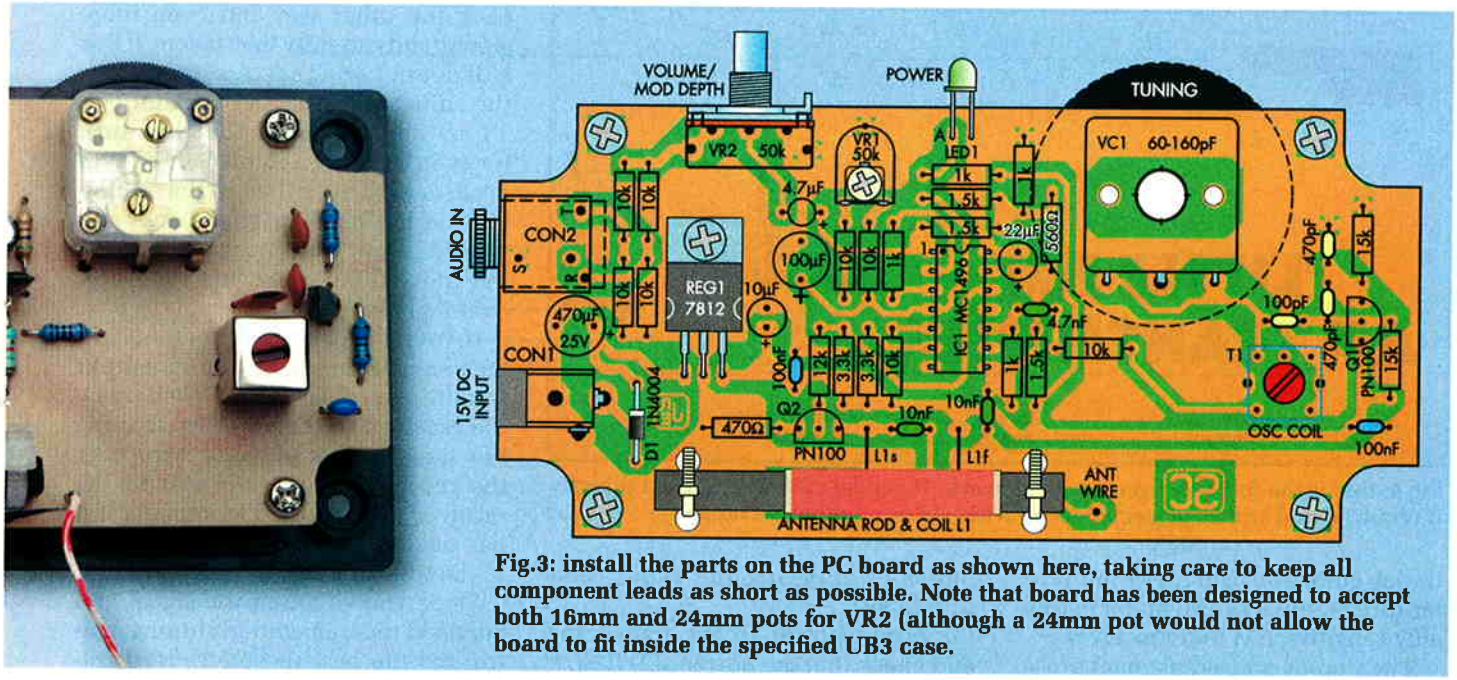


Fig.3: install the parts on the PC board as shown here, taking care to keep all component leads as short as possible. Note that board has been designed to accept both 16mm and 24mm pots for VR2 (although a 24mm pot would not allow the board to fit inside the specified UB3 case.

to check all lead combinations with an ohmmeter and go with the combination that gives the highest reading – typically around 11Ω.

Another little trap is that with many of these coils, the intermediate leads actually consist of two fine gauge insulated wires, twisted tightly and soldered together at their outer ends. This means that if you decide to cut these leads short, they must be bared and soldered together again – otherwise you'll find that the coil has become an open circuit between start and finish. And of course, the transmitter won't function very well with L1 open circuit, as this prevents Q2 from drawing current!

A word of advice: if you do shorten any of the coil leads, it's a good idea to check the coil continuity with your multimeter before you solder the start and finish leads to the board.

The last step in wiring up the board is to solder the end of a 2-metre length of insulated hookup wire to the "ANT WIRE" terminal pin at the end of the antenna rod. That done, it's time to fit the tuning "disc knob" to VC1's shaft and fasten it in place using the remaining M2.5 x 4mm screw.

The board assembly is now ready to attach to the box lid (used here as the transmitter's base). Before doing this, however, you may need to drill and cut the various holes in both the lid and the box itself, if you're building the project from scratch. The location, size and shape of each of the holes is shown in Fig.5.

Alternatively, if you've purchased a complete kit, the box will probably be supplied predrilled, with screened graphics for the front panel.

The PC board assembly is secured to the lid using four M3 x 10mm tapped spacers and eight M3 x 6mm machine screws (see photo). Once that's been done, it's time to check the transmitter's operation.

Table 1: Capacitor Codes

Value	µF Code	EIA Code	IEC Code
100nF	0.1µF	104	100n
10nF	.01µF	103	10n
4.7nF	.0047µF	472	4n7
470pF	NA	470	470p
100pF	NA	100	100p

Checkout & adjustment

It's easy to check and adjust the transmitter's operation using a frequency counter, an oscilloscope and an audio signal generator. However, these are not essential and you can do

Table 2: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	2	15kΩ	brown green orange brown	brown green black red brown
❑	1	12kΩ	brown red orange brown	brown red black red brown
❑	8	10kΩ	brown black orange brown	brown black black red brown
❑	2	3.3kΩ	orange orange red brown	orange orange black brown brown
❑	3	1.5kΩ	brown green red brown	brown green black brown brown
❑	4	1kΩ	brown black red brown	brown black black brown brown
❑	1	560Ω	green blue brown brown	green blue black black brown
❑	1	470Ω	yellow violet brown brown	yellow violet black black brown

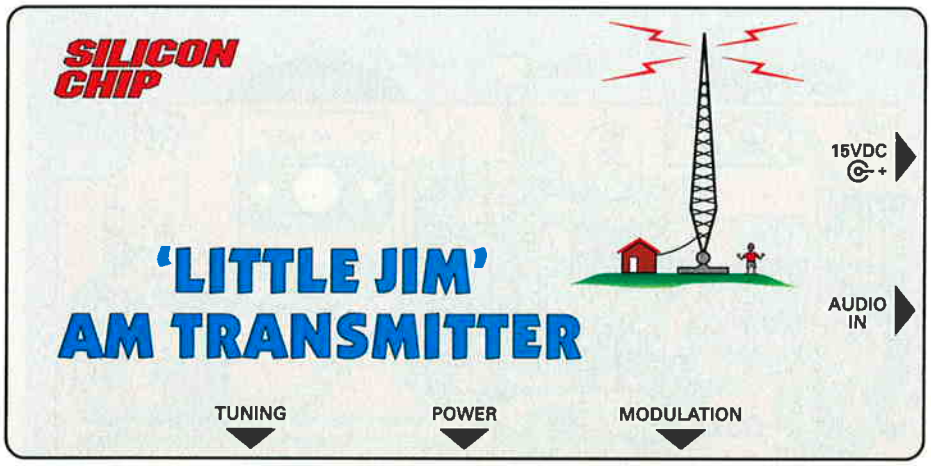


Fig.4: this is the full-size front-panel artwork. It can be cut out and used directly if required and can be protected using wide strips of adhesive tape.

the job quite well using just a multimeter (preferably a DMM) and a reasonably sensitive AM radio receiver.

The step-by-step adjustment procedure is as follows:

(1) Switch the radio on and tune it to a convenient frequency in the lower section of the broadcast band, away from any of the local broadcasting stations (in Sydney, you can tune to about 820kHz).

(2) Turn the volume up (you'll just hear static at this stage) and position the radio near the transmitter, orientated so that its internal ferrite rod antenna is roughly parallel to the transmitter's ferrite rod.

(3) Turn the transmitter's tuning control (VC1) to one end of its range, set trimpot VR1 well away from its centre position (this is important) and set VR2 (modulation depth) to its midrange position.

(4) Turn the adjustment slug in T1 anticlockwise a couple of turns using a small screwdriver or alignment tool.

(5) Feed a stereo audio signal from your MP3 or CD player into the transmitter by plugging the audio cable into CON2.

(6) Apply power to the transmitter and check that the power LED (LED1) lights. If it doesn't, unplug the power lead and look for your wiring mistake. You've probably fitted either D1 or LED1 with reversed polarity.

(7) Use your DMM to check the supply voltage at the output pin of REG1, relative to board earth; it should be very close to +12V. Check that the voltage at pin 8 of IC1 is close to +6V (if these voltages check out correctly, your transmitter is very likely to be working correctly).

(8) Listen carefully to the radio while you turn the transmitter's tuning knob *very slowly* towards the other end of its range. At some point, you should start to hear the music from your MP3 or CD player, after which you should be able to tune the transmitter so that its signal is received at a good strength.

Troubleshooting

Can't find the signal? The first thing to do is to try tuning the transmitter back the other way but even more slowly and carefully than before. If this still doesn't bring success, try turning the adjustment slug in oscillator coil T1 anticlockwise another half-turn (or even a full turn if this later proves necessary). This will shift the oscillator's tuning range up in frequency and should allow you to correctly adjust the transmitter when you tune VC1 over its range again.

If you still can't find the transmitter's signal, it may be that its output is a little too weak to be picked up by the receiver. In that case, try draping the transmitter's antenna wire over the receiver, or twist it around the receiver's telescopic FM antenna if it has one, just to couple in a bit more of the transmitter's output.

Once you've found the signal and adjusted the transmitter's tuning control for the best reception, try turning up the transmitter's modulation control (VR2). This should make the reception even louder and clearer but if you turn the control up too far, the music will become distorted. Just back it off again until the distortion disappears.

You can also try adjusting trimpot VR1, because a small amount of adjustment one way or the other can also improve transmission clarity. That said, you'll find that its optimum position is about halfway between the centre and one of the end positions of the rotor (on either side).

Don't set this trimpot (VR1) too close to its midway (centre) position, because this balances out the RF carrier altogether and gives double sideband (DSB) suppressed carrier modulation. And that gives and quite high distortion when you're using a normal AM receiver.

Once all the adjustments have been made, your Little Jim AM Transmitter is working correctly and you're ready for the final assembly.

Final assembly

If your UB3 box has vertical PC board mounting ribs inside, you'll also have to cut some of these away. That's because the transmitter board assembly is a fairly tight fit inside the box and the ribs foul the ferrite rod and its coil.

The ribs to remove are mainly those at the rear side of the box, where they interfere with the ferrite rod. However it's also a good idea to cut away any

Vintage Australian Radio Programs On CD

If you'd like to rebroadcast genuine old time Aussie radio programs through your "Little" Jim AM Transmitter, you should know that many of the programs are now available on CD from ScreenSound Australia (the National Screen and Sound Archive).

Currently they have some 11 different CDs available, with classic "golden age of radio" programs, including quiz shows, serials like Dad & Dave and Mrs 'Obbs, comedies like The Bunkhouse Show and McCackie Mansion, and so on. All CDs are currently available for $24.95 each, including GST (but not postage).

For more information on what's available, visit the ScreenSound website at **shop.screensound.gov.au**. You can even buy the CDs direct via their secure online purchasing system.

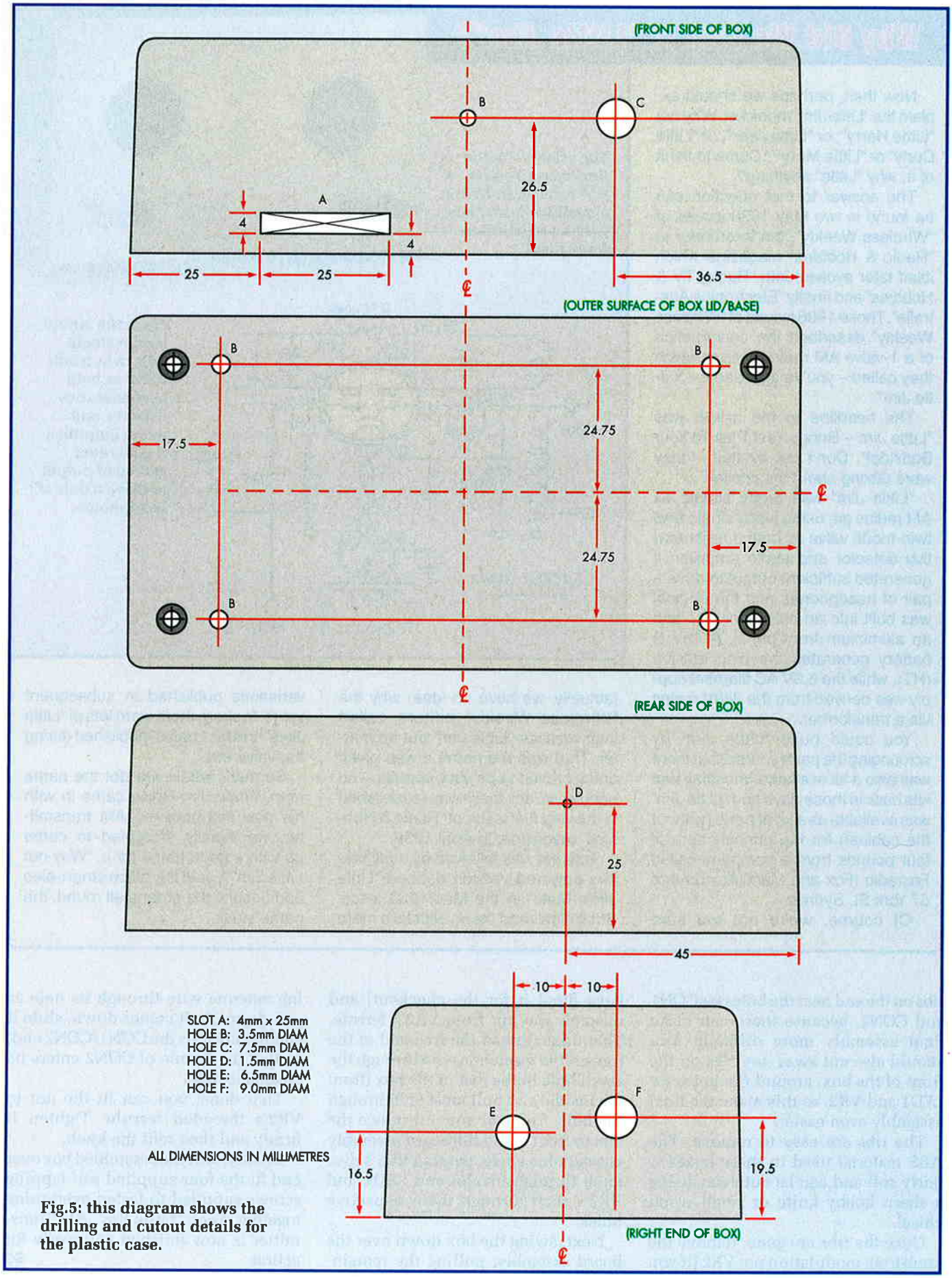


Fig.5: this diagram shows the drilling and cutout details for the plastic case.

Why Did We Call It "Little Jim"?

Now then, perhaps we should explain the "Little Jim" monicker. Why not "Little Harry", or "Little Jack", or "Little Curly" or "Little Mary"? Come to think of it, why "Little" anything?

The answer to that question can be found in two May 1938 issues of "Wireless Weekly", the forerunner to "Radio & Hobbies" magazine which itself later evolved into "Radio, TV & Hobbies" and finally "Electronics Australia". Those 1938 issues of "Wireless Weekly" described the construction of a 1-valve AM radio receiver which they called – you've guessed it – "Little Jim".

The headline to the article was "Little Jim – Brings Test Play To Your Bedside!". Don't get excited – they were talking about the cricket!

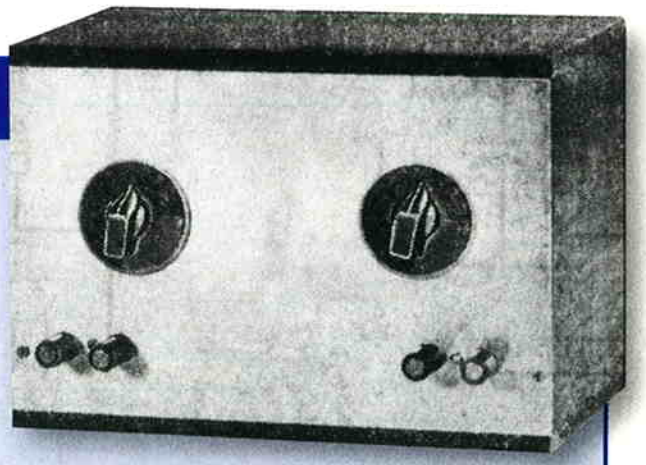
"Little Jim" was pretty simple as AM radios go, using just a single 6A6 twin-triode valve as both a regenerative detector and audio amplifier. It generated sufficient output to drive a pair of headphones and the original was built into an old butter box with an aluminium front panel. A 45V B battery generated the high tension (HT), while the 6.3V AC filament supply was derived from the 240V mains via a transformer.

You could build "Little Jim" by scrounging the parts yourself but there was also a kit available. Yes, they had kits back in those days and "Little Jim" was available as a kit of parts (without the cabinet) for the princely sum of four pounds from a company called Foxradio (Fox and MacGillicuddy) of 57 York St, Sydney.

Of course, we're not too sure (actually, we have no idea) why the "Wireless Weekly" editors called their receiver "Little Jim" but no matter. That was the name it was given and it proved to be very popular – so popular, in fact, that it was republished in the very first issue of "Radio & Hobbies" magazine, in April 1939.

That set was followed by a full battery-powered version dubbed "Little Jim's Mate" in the May 1939 issue. But it didn't end there, with lot's more variations published in subsequent years. In short, there were lots of "Little Jims" and his "mates" published during the valve era.

So that's where we got the name from. When Jim Rowe came in with his new flea-powered AM transmitter, we initially struggled to come up with a good name for it. "Why not Little Jim?", said the office smart-elec and despite the groans all round, the name stuck.



The original "Little Jim" was a 1-valve AM receiver built into a modified butter box, with an aluminium front panel.

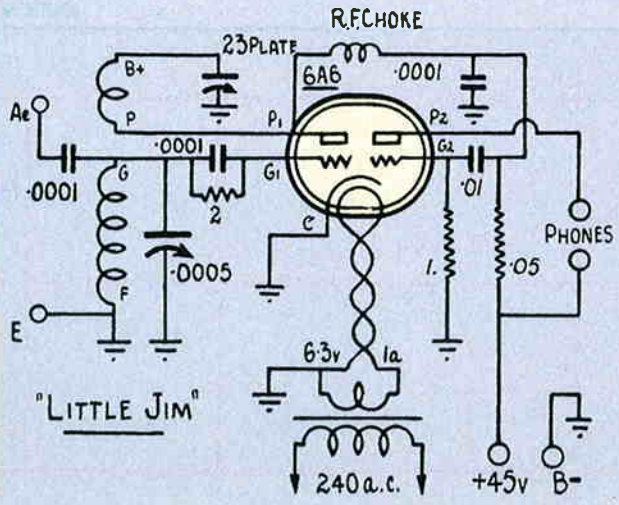


Fig.6: the circuit used a single 6A6 twin-triode valve as both a regenerative detector and audio amplifier. It generated sufficient output to drive a pair of headphones

ribs on the end near the holes for CON1 and CON2, because these can make final assembly more difficult. You should also cut away any ribs on the front of the box, around the holes for LED1 and VR2, as this make the final assembly even easier.

The ribs are easy to remove. The ABS material used in these boxes is fairly soft and can be cut away using a sharp hobby knife or small wood chisel.

Once the ribs are gone, remove the knob from modulation pot VR2 (if you have fitted it for the checkout) and unscrew the nut from VR2's ferrule. That done, thread the free end of the transmitter's antenna wire through the small hole in the rear of the box (from the inside) and pull most of it through the hole. You can now introduce the box to front of the lid/board assembly at a suitable angle, passing VC1's disc knob through its slot and LED1 and VR2's shaft through their respective holes.

Next, swing the box down over the board assembly, pulling the remaining antenna wire through its hole as you do so. As it comes down, slide it slightly towards the CON1/CON2 end, so that the ferrule of CON2 enters its clearance hole.

That done, you can fit the nut to VR2's threaded ferrule. Tighten it firmly and then refit the knob.

Finally, turn the assembled box over and fit the four supplied self-tapping screws supplied to fasten everything together. Your "Little Jim" AM Transmitter is now finished and ready for action. **SC**

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CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.

Bob Hammond is this month's winner of a Peak Atlas Test Instrument

Winch controller for boaties & 4WDers

Australia has a high percentage of domestic boat ownership, with over 600,000 registered owners in 2000. Winches are a necessary part of the gear and are typically used with boat trailers and on slipways. They're also very popular on 4WD vehicles for use in the bush. Here is a companion winch controller that (with its remote control) will make your boat or 4WD ownership even more enjoyable.

At the heart of the design is a PICAXE micro, which receives "rope in", "rope out" and "all stop" commands via pushbutton switches or wireless remote control. In response, it controls the winch motor using two power relays (see Fig.1).

The complete circuit diagram for the winch controller appears in Fig.2. Looking first at the microcontroller inputs (P1, P3 & P4), these all originate from the pushbutton switches (S1-S3) and RF decoder (IC1) outputs, as well as the two limit switches (S4 & S5).

All inputs are "deglitched" with the aid of identical monostable circuits, comprised of one inverter gate and two NAND gates plus a few resistors and capacitors. The monostable circuits provide a clean, 100ms positive pulse to the associated PICAXE input when their inputs transition from high to low, ignoring subsequent switch contact bounce or spurious noise from the RF receiver outputs.

Two port pins of the PICAXE (P0 & P2) are configured as outputs to drive transistors Q1 & Q2, which in turn control two high-power relays. In the relaxed (normally-closed) state, the relay contacts short the motor terminals together; this is the "all stop" position.

When the "rope in" switch is pressed, the program sets *output0* (P0) high and relay RLY1 is energised, connecting power to one side of the motor to retract the winch cable. Alternatively, when the "rope out" switch is pressed, *output2* (P2) goes high and RLY2 is energised, reversing the direction of the motor and therefore releasing the winch cable.

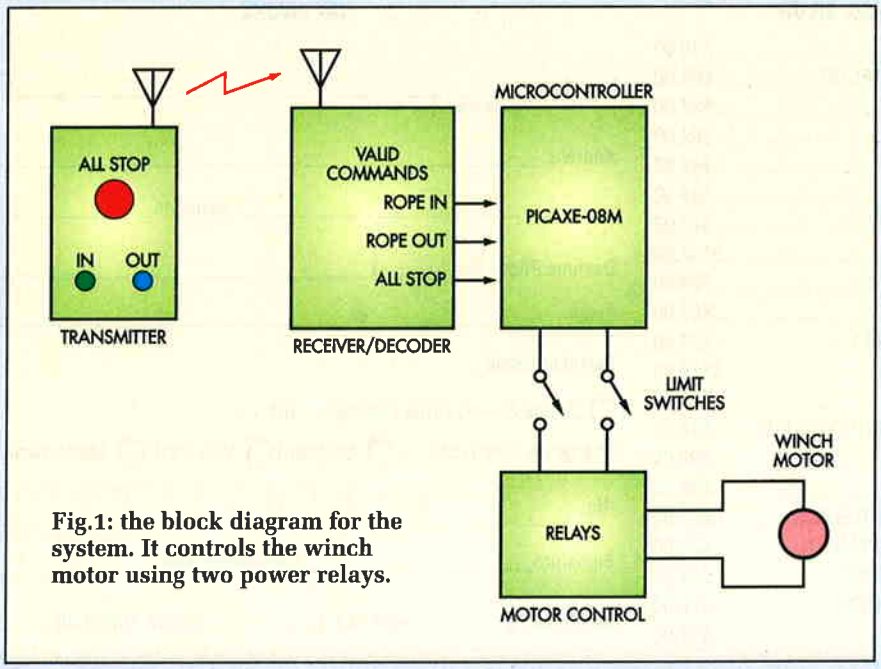

Fig.1: the block diagram for the system. It controls the winch motor using two power relays.

Stress limits

Limit switches are used in this application to (indirectly) switch off the motor when the cable is fully retracted or deployed, to prevent excessive strain being placed on the winching system.

Limit switches should be used if the winch design supports them. To illustrate the need for these switches, imagine that the fishing is finished for the day and the boat has been winched into the shed. During winching, the "in" limit switch has opened, removing power to the motor. This switch now forms a kind of "memory", so that days later, when the winch is switched on again, it cannot be accidentally operated in the wrong direction.

Consider the "in" limit switch action, for example. Initially, with RLY1 energised, the winch will be running. When the cable fully retracts, the "in" limit switch (S4) is physically contacted, changing its pole to the alternate position and removing drive current to the base of Q1. This immediately de-energises the relay and switches off the motor.

Now in the alternate position, the switch contacts connect *output0* of the PICAXE (P0) to diode D11 and the input of a monostable circuit. The result is a clean, positive-going pulse at *input3* (P3) of the micro. On detecting the pulse, the BASIC program responds by taking *output0* low and then waiting for the next command.

The signal path from *output0* to transistor Q1 and the relay are now open circuit, preventing the "rope in" command from having any further effect until the "rope out" command is used to play out some slack. This safeguards against overrunning the limit switch. The

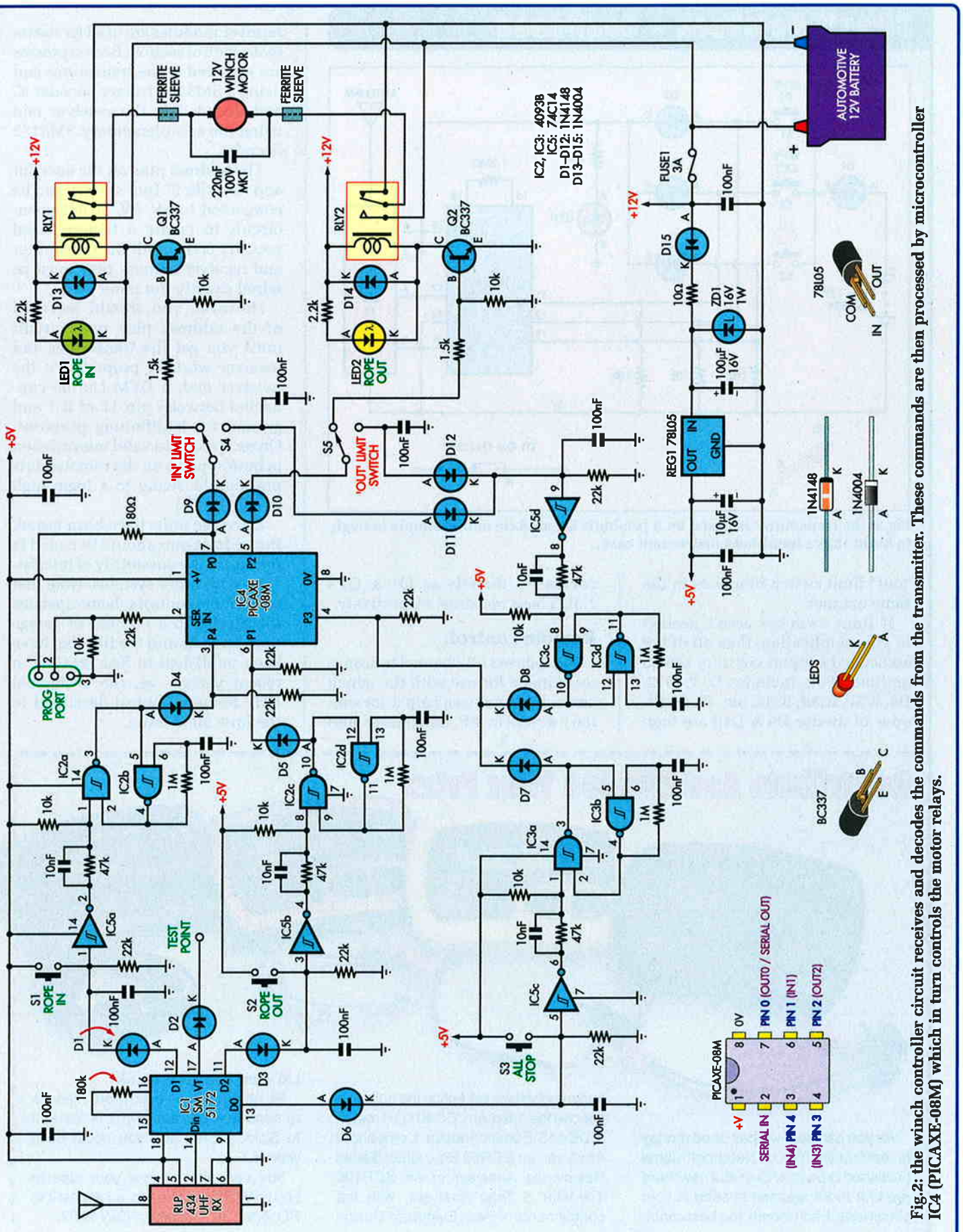

Fig.2: the winch controller circuit receives and decodes the commands from the transmitter. These commands are then processed by microcontroller IC4 (PICAXE-08M) which in turn controls the motor relays.

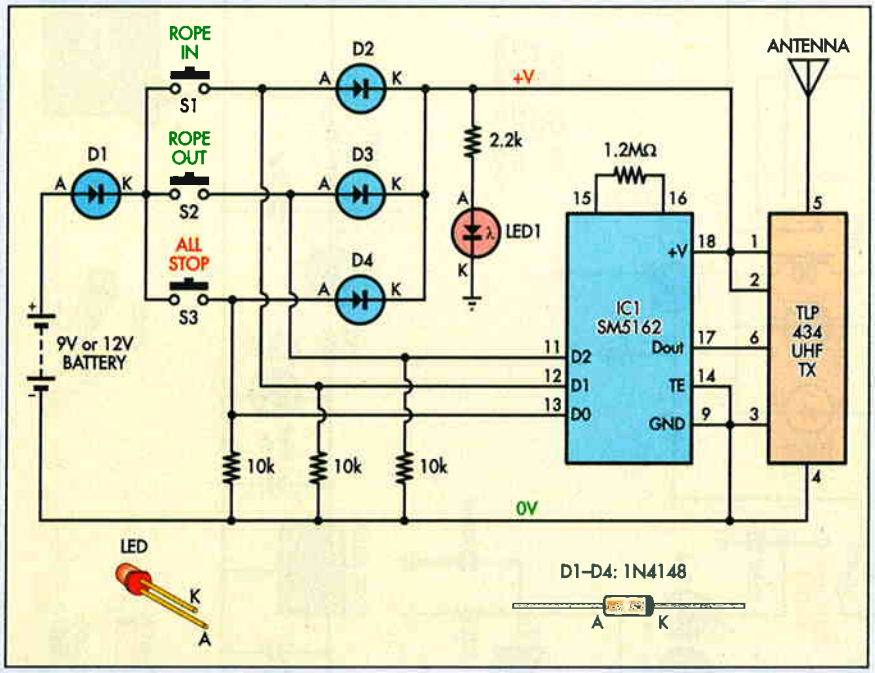

Fig.3: the transmitter is based on a pre-built RF module and is simple enough to build into a hand-held instrument case.

"out" limit switch functions in the same manner.

If limit switches aren't needed in your application, then all of the associated support circuitry can be omitted. This includes D11, D12, D8, IC3c, IC3d, IC5d, etc. The cathodes of diodes D9 & D10 are then connected directly to Q1 & Q2's 1.5kΩ base resistors, respectively.

Remote control.

Fig.3 shows a 3-channel transmitter suitable for use with the winch controller. Low-cost Laipac (or similar) 433MHz RF transmitter and receiver modules are used for the remote control section. Button presses are encoded at the transmitter end using a SM5162 trinary encoder IC and decoded at the receiver end using the complementary SM5172 decoder.

The address pins on the encoder and decoder IC (not shown) can be connected to +V, 0V, or left open-circuit to create a trinary-based security code. Both the transmitter and receiver address pins must be wired exactly the same way.

However, you should leave all of the address pins open-circuit until you get the transmitter and receiver working properly. At the receiver end, a DVM can be connected between pin 17 of IC1 and ground for faultfinding purposes. On reception of a valid transmission (a button press on the remote), this pin should swing to a logic high (about +4.7V).

Once the units have been tested, the address pins should be coded to minimise the possibility of interference with other systems. Note that this remote control scheme operates identically to a number of garage door openers and the like that have been published in SILICON CHIP in recent years – eg, the 4-Channel UHF Remote Control described in the June 2003 issue.

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Datasheets for the Laipac TLP-434 transmitter and RLP-434 receiver modules are available from **www.laipac.com**. Compatible 433MHz modules are available from all major kit suppliers. Oatley Electronics sells the encoder and decoder ICs (stock codes SM5162RF & SM5172RF). Check 'em out at **www.oatleye.com**, with datasheets available from **www.samhop.com.tw**.

Antenna choices

For operation at 433.92MHz, a quarter-wavelength antenna needs to be 172mm long. If you are using a plastic case for the transmitter, then a 172mm length of wire may be wound into an oblong and glued inside the case. Alternatively, an extendable rod antenna could be used.

The receiver requires only a wire cut to 172mm, although it too could use a rod antenna. With a little fine-tuning, a range of approximately 50-60 metres is easily obtainable.

Although greater range is possible by using more elaborate antennae, safety is an overriding factor. You should always be in visual contact with the winch and the load that is being winched, to guard against injury to others.

The BASIC program

The PICAXE program for this application is self-explanatory. Of note is the use of the '08M's interrupt feature to detect positive transitions on *input3*, which can originate from the "all stop" switch or the limit switches.

Once up and running, check that the winch comes to a complete stop before reversing direction when the "rope out" and "rope in" buttons are pressed in quick succession. The length of the pause command in the *Init:* section of the program can be trimmed to ensure that this occurs.

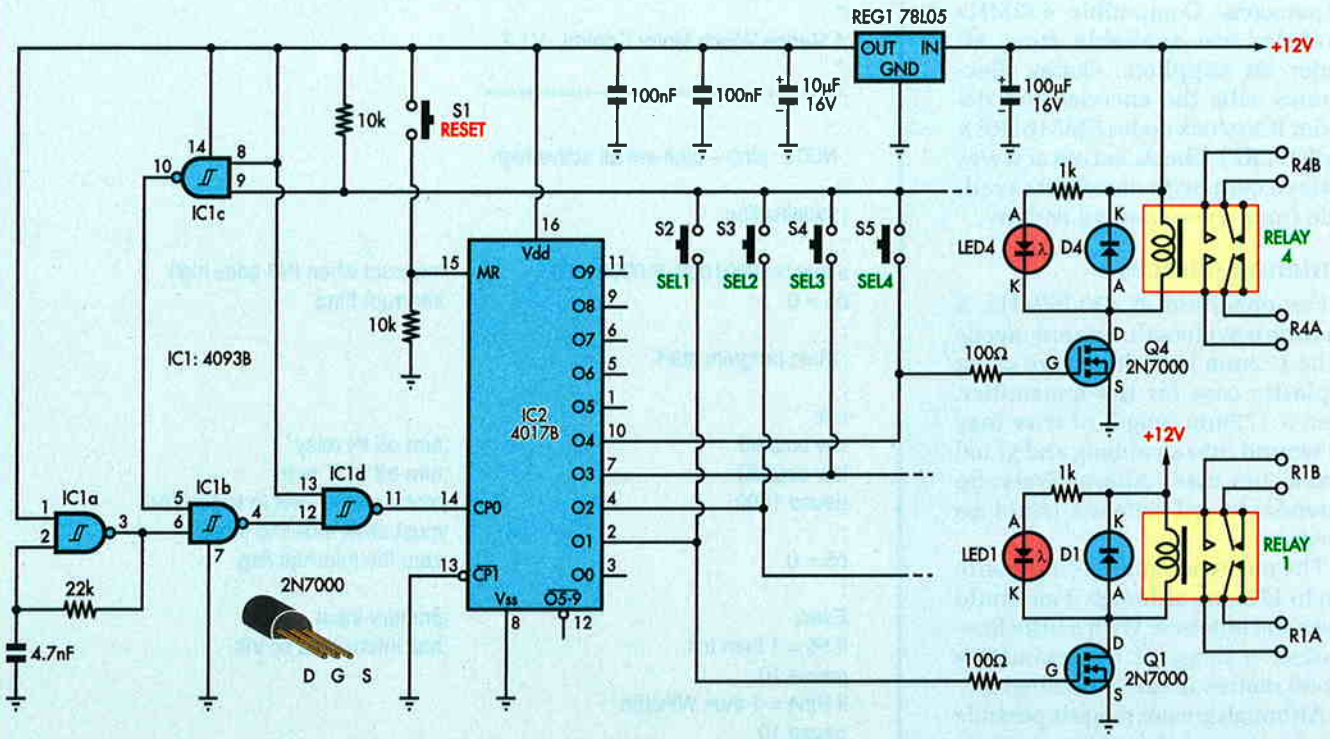
Finally, the author recommends the use of high-quality pushbutton switches to ensure reliable, long-term operation. While the monostable circuits will remove switch contact bounce, they cannot compensate for faulty switch contacts!

Bob Hammond,
Engadine, NSW.

Program Listing

```
;*****************************************
;*
;* Marine Winch Motor Control  V1.7
;*
;*****************************************
;
; NOTE: pin0 – pin4 are all active high
;
; Initialisation
;
setint %00001000, %00001000          ;interrupt when IN3 goes high
b5 = 0                               ;interrupt Flag
;
; Main program start
;
Init:
low output0                          ;turn off IN relay
low output2                          ;turn off OUT relay
pause 1000                           ;motor pause - set to suit motor,
;                                    ;must allow motor to stop
b5 = 0                               ;zero the interrupt flag
;
Exec:                                ;primary input
if b5 = 1 then Init                  ;has interrupted so init
pause 10
if Pin4 = 1 then WinchIn
pause 10
if Pin1 = 1 then WinchOut
goto Exec
;
NextSwitch:                          ;secondary switch point
if b5 = 1 then Init                  ;has interrupted so init
pause 10
if pin4 = 1 then Init
pause 10
if pin1 = 1 then Init
pause 10
goto NextSwitch
;
WinchIn:                             ;rope in
if b5 = 1 then Init                  ;has interrupted so init
high output0                         ;pull the rope in
pause 300                            ;settle time
goto NextSwitch
;
WinchOut:                            ;rope out
if b5 = 1 then Init                  ;has interrupted so init
high output2                         ;let the rope out
pause 300                            ;settle time
goto NextSwitch

end                                  ;should not get here!
;
Interrupt:
low output0                          ;switch off IN relay
low output2                          ;switch off OUT relay
input3 = 0                           ;reset pin3 for next interrupt
b5 = 1                               ;set the interrupt flag
setint %00001000, %00001000          ;restore interrupt
return
```



Pushbutton relay selector

This circuit was designed for use in a hifi showroom, where a choice of speakers could be connected to a stereo amplifier for comparative purposes. It could be used for other similar applications where just one of an array of devices needs to be selected at any one time.

A bank of mechanically interlocked DPDT pushbutton switches is the simplest way to perform this kind of selection but these switches aren't readily available nowadays and are quite expensive.

This simple circuit performs exactly the same job. It can be configured with any number of outputs between two and nine, simply by adding pushbutton switches and relay driver circuits to the currently unused outputs of IC2 (O5-O9).

Gate IC1a is connected as a relaxation oscillator which runs at about 20kHz. Pulses from the oscillator are fed to IC1b, where they are gated with a control signal from IC1c. The result is inverted by IC1d and fed into the clock input (CP0) of IC2.

Initially, we assume that the reset switch (S1) has been pressed, which forces a logic high at the O0 output (pin 3) of IC2 and logic lows at all other outputs (O1-O9). As the relay driver transistors (Q1-Q4) are switched by these outputs, none of the relays will be energised after a reset and none of the load devices (speakers, etc) will be selected.

Now consider what happens if you press one of the selector switches (S2-S5, etc). For example, pressing S5 connects the O4 output (pin 10) of IC2 to the input (pin 9) of IC1c, pulling it low. This causes the output (pin 10) to go high, which in turn pulls the input of IC1b (pin 5) high and allows clock pulses to pass through to decade counter IC2.

The 4017B counts up until a high level appears at its O4 output. This high signal is fed via S5 to pin 9 of NAND gate IC1c, which causes its output (pin 10) to go low. This low signal also appears on pin 5 of IC1b, which is then inhibited from passing further clock pulses on its other input (pin 6) through to its output (pin 4), thus halting the counter.

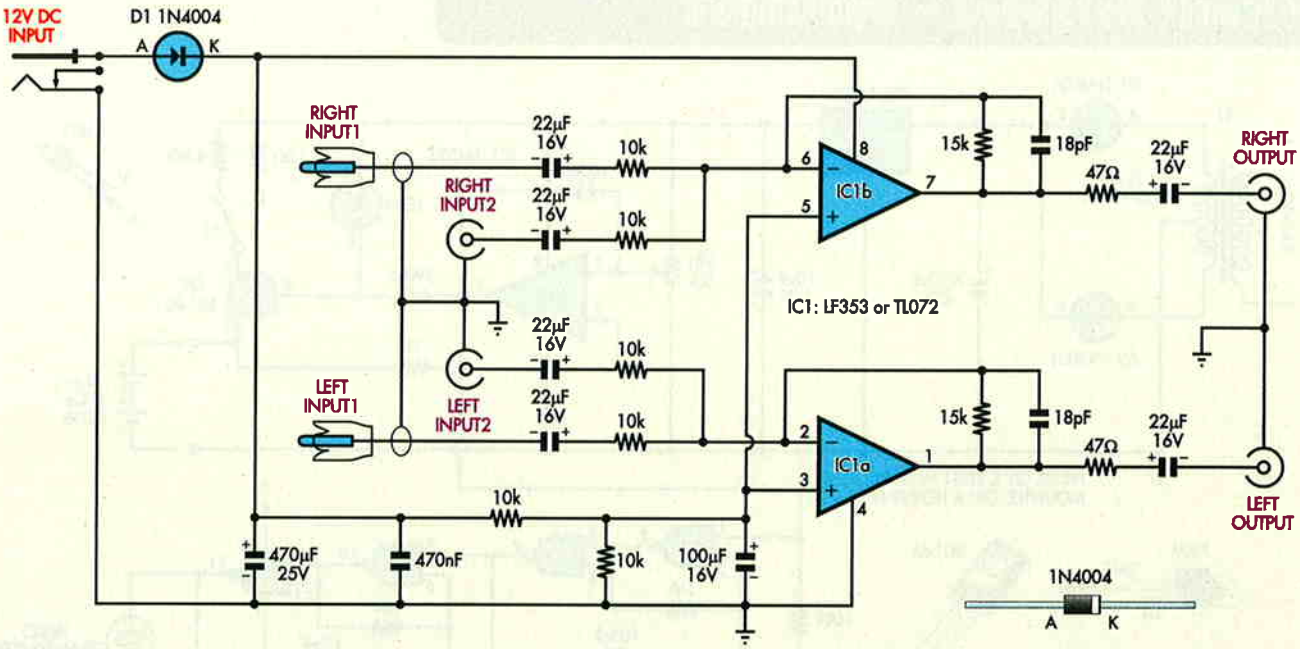
So, the counter runs just long enough to make the output connected to the switch that is pressed go high. This sequence repeats regardless of which selector switch you press, so the circuit functions as an electronic interlock system.

Each relay driver circuit is a 2N7000 FET switch with its gate driven from one output of IC2 via a 100Ω resistor. The relay coil is connected from the drain to the +12V supply rail, with a reverse diode spike suppressor across each coil.

If you want visual indication of the selected output, an optional indicator LED and series resistor can be connected across each relay coil, as shown. For selecting pairs of stereo speakers, we'd suggest the use of relays like the Jaycar SY-4052. These operate from 12V and have DPDT contacts rated for 5A.

Note that although four selector switches are shown in the circuit, only two relay drivers are shown because of limited space. For a 4-way selector, identical relay drivers would be driven from the O2 and O3 outputs of IC2.

Jim Rowe,
Silicon Chip.



Dual input-combining stereo line amplifier

This circuit takes two separate line-level stereo (L & R) signals and combines them into one stereo (L & R) output, thus avoiding the need to switch between two pairs of input signals. In the author's application, it is used to feed the stereo audio from a TV receiver and a DVD player into an external amplifier.

The need for the circuit arose because of a design peculiarity in the TV receiver. The TV has four A/V inputs and one A/V output. AV1-AV3 accept composite or S-video plus stereo audio inputs and these feed into the TV's A/V output. AV4 accepts Component video (Y/Pb/Pr) plus stereo audio but unlike AV1-AV3, its audio (and video) signals are not fed to the TV A/V output.

The Y/Pb/Pr input was chosen for use with the DVD player because of its superior video quality, while the audio was to be fed to an external amplifier for improved reproduction. However, manual switching was inconvenient, hence the genesis of this design.

In use, the DVD player audio is fed in parallel to TV AV4 and to one input pair of the combining amplifier, while the TV audio output feeds the other input pair. The amplifier output goes to the external audio amplifier. There is no conflict between the two audio inputs because when AV4 (DVD player) is selected, there is no TV audio output. In all other modes, the DVD player is off.

As shown, the circuit has a voltage gain of 1.5 times (3.5dB) but this can be altered as required by changing the two 15kΩ resistors. Input impedance is 10kΩ and the outputs are isolated from cable and amplifier input capacitance with 47Ω series resistors.

The circuit can be powered from a regulated 12V DC plugpack.

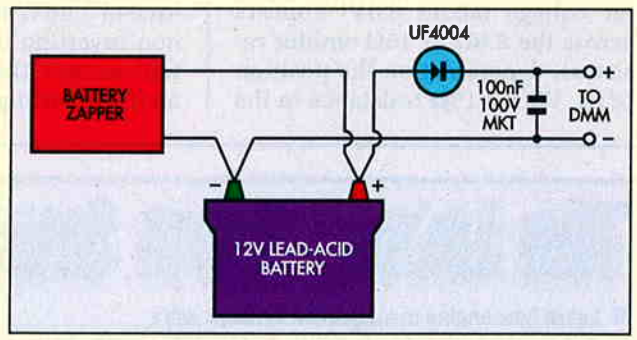
Garth Jenkinson,
Emerald, Vic. ($40)

Battery desulphation progress monitor

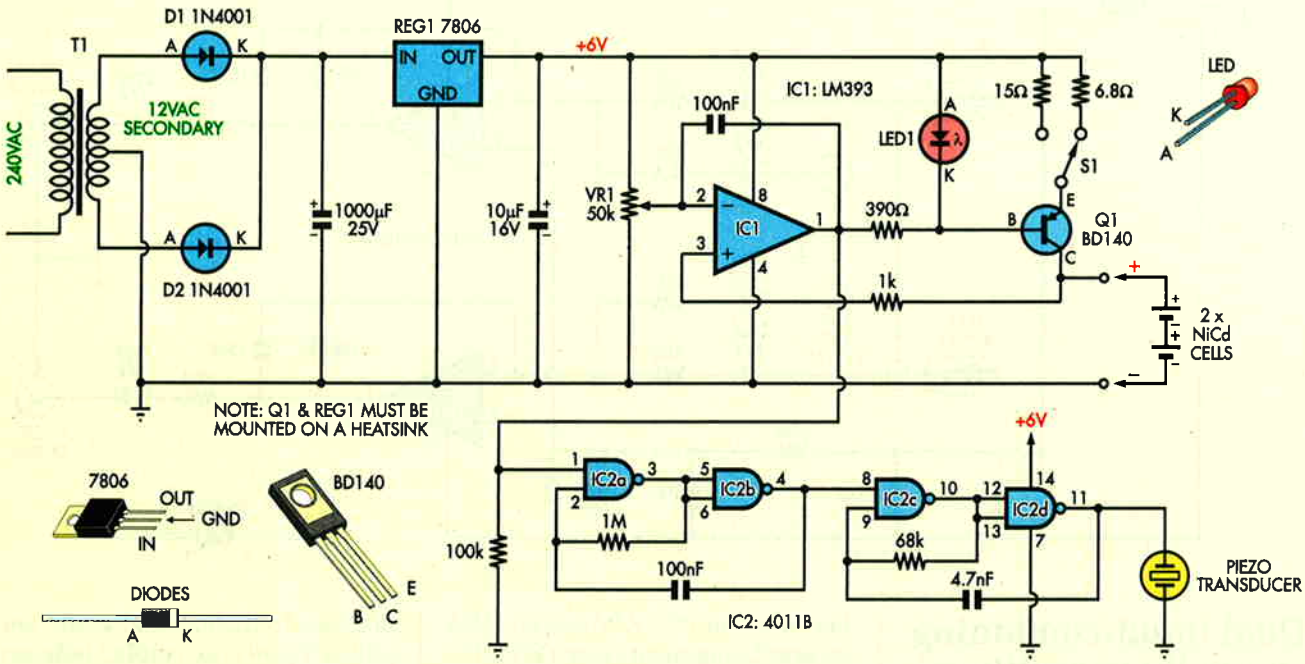
A number of readers have asked how to tell when the Lead-Acid Battery Zapper (SILICON CHIP, July 2005) has done its job and battery desulphation is complete.

In the author's experience, batteries that are going to respond to this treatment will generally show quite a high peak voltage across the terminals at the beginning of the treatment. If this steadily decreases and practically disappears, then the treatment is near to complete. This may take anything from a week to many months, depending on the size and condition of the battery.

In the absence of an oscilloscope to monitor the voltage peaks, a simple peak detector can be constructed from a fast diode and 100nF capacitor. Any high-impedance multimeter (eg, most digital types) can then be used to measure the average DC voltage across the capacitor.



Graham Lill,
Lindisfarne, Tas. ($30)



Nicad charger uses voltage cut-out

This circuit charges two NiCad cells with a constant current and features dual charging rates, voltage cutoff and an audible alarm.

The circuit is powered by a 12VAC centre-tapped mains transformer, together with two rectifier diodes (D1 & D2) and a 1000µF filter capacitor. A 7806 3-terminal regulator is used to generate a 6V rail for the remainder of the circuit.

Transistor Q1 and LED1 constitute a basic constant-current source. The forward voltage of the red LED (about 1.5V) minus Q1's base-emitter voltage (about 0.6V) appears across the 6.8Ω or 15Ω emitter resistors, depending on the position of S1. With a 15Ω resistance in the emitter circuit, the charging current is about 60mA, whereas with 6.8Ω it is about 130mA. This is sufficient to charge 600mAH "AA" cells in 14 hours and five hours, respectively.

An LM393 voltage comparator (IC1) is used for the voltage cutoff function. Its inverting input is set to 2.9V (nominal) via trimpot VR1, while the non-inverting input senses battery voltage. This means that while the cells are being charged, the output transistor (in the LM393) is switched on, also switching on Q1 and enabling the current source.

Once the cells are charged to approximately 80% or more of capacity, their terminal voltages will exceed 1.45V, so the voltage at the non-inverting input (pin 3) of IC1 will exceed the reference voltage on the inverting input (pin 2). This causes IC1's output to switch off, in turn switching Q1 off and disabling the current source.

To prevent rapid switching action around the voltage cutoff point, a 100nF capacitor provides feedback between the output and inverting input of the comparator.

Four NAND gates are used to build two simple oscillators of different frequencies. When cascaded together, the result is a pulsed tone from the piezo transducer to indicate charge completion.

Editors note: absolute terminal voltage is not always a reliable indicator of Nicad battery charge state. Importantly, batteries should never be charged for longer than the manufacturer's specified period.

Ravi Sumithraarachchi, Colombo, Sri Lanka. ($45)

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COIN HOPPER WITH COIN DISPENSING / COUNTING MECHANISM.

This mechanism was designed as part of a vending machine, it suits $1AU coins. It has a 24V motor & gearbox (all metal gears) & an optical switch to count coins. At 1.8V the motor will start running, it is difficult to stop the output shaft with your fingers at this voltage. The two 8mm gearbox output shafts turn in opposite directions, they have a flat on each & our SPR300 sprocket fits the shaft. The combination of our SPR300 11 tooth sprocket & our CHAINSP 80 tooth chain and sprocket set would give a slow & powerful output (approx. 15RMP @ 24V or 0.96 RPM @ 2V). This motor & gearbox with chains & sprockets could be used to open doors & gates etc. (see our garage door controller kit K023C).Some approx. voltage/current & RPM figures of the motor/gearbox. 2V 80mA 7RPM, 6V 100mA 30RPM, 12V 120mA 60RPM, 18V 140mA 110RPM, Overall dimensions of the hopper assembly: 93mm(W) X 126mm(L) x 126mm(H).

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24 SECOND VOICE / SOUND RECORDER MODULE

This small pre-built module will record up to 24 seconds of sound at the push of a button, then play it back at the push of a second button. Requires 6VDC to operate. Measures 34mm X 22mm Comes with a 29mm speaker **VRM1**$10

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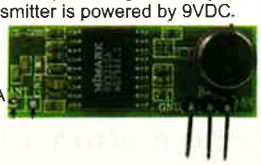
We have new replacement UHF434 TX and RX modules. These give equal or better range than our previous modules.

RX434A SUPERHETERODYNE RECEIVER

MODULE: Pre-built superheterodyne surface mount receiver module which is crystal locked at 433.92MHz. It has a high sensitivity, operates from 5V DC supply. It is designed for use with TX434A. When used in conjunction with TX434A, the pair can give a range of over 1km when the transmitter is powered by 9VDC.
Frequency:433.92MHz
Transmit rate: 9.6KB/S
Modulation: A.S.K.
Voltage:5VDC @ 2.6mA
Size: 35mm X 17mm
(RX434A) $8



TX434A SUPER-REGENERATION TRANSMITTER

MODULE: Pre-built superheterodyne surface mount transmitter module which is crystal locked at 433.92MHz. Operates from 3-12V DC supply. It is designed for use with RX434A. When used in conjunction with RX434A, can give a range of over 1km when the transmitter is powered by 12V DC.
Frequency:433.92MHz
Transmit power: 10mW @ 12V
Modulation: AM
Voltage:3-12VDC @ 15mA
Size: 14mm X 14mm (TX434A) $6

K224 3 CHANNEL TO 7 CHANEL INFRA-RED REMOTE CONTROL KIT

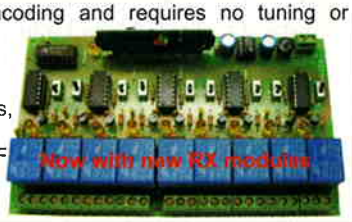
Up to three kits can be used together to make a 21 Ch. system to operate from one remote control. The basic kit includes the PCB & all onboard components to build a 3 Ch. IR remote control including relays and screw terminals. The additional components required to expand to 7 Ch. are available in the K224E kit. If not used the remaining 4Ch. section of the PCB can be snapped off to reduce the overall size of the kit.
3 channel kit $25 (K224R)
4 channel expansion kit $11(K224E)
Remote control (pre-built)$6 (K224T)
Complete package 7 channel kit with remote control $39 (K224P)

9Ch UHF REMOTE CONTROL TRANSMITTER KIT.
Now with new TX modules

The prebuilt UHF module used in this kit requires no tuning or alignment. This kit includes PCB, all onboard components, prebuilt UHF module, 9V battery clip, suitable case & membrane type keypad / label. Requires a 9V battery (not supplied). K226T $27.

9Ch UHF REMOTE CONTROL RECEIVER KIT.

This Kit uses our K226T kit to control 9 relays that can be set in any combination to momentary or latching at the flick of a switch. It can be used to switch just about anything on or off, lights, motors etc. This kit can also be used with our TX7.
The pre-built UHF module used in this kit has security encoding and requires no tuning or alignment.
Kit inc. all onboard components, PCB and prebuilt UHF module.
$55 K226R



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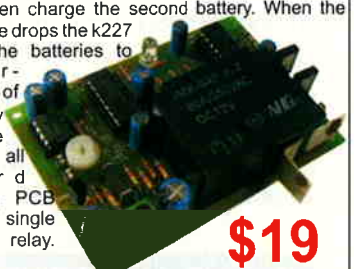
K229 AUDIO / VIDEO TRANSMITTER / RECEIVER KIT

This kit (K229T and K229R) are designed to transmit and receive video and stereo audio. The TX has been designed to be as small as practical. (TX kit) 13mm(H) X 30mm(W) X 30mm(D). (RX kit) 17mm(H) X 50mm(W) X 62mm(D) with connectors). Construction is simple and the pre-built modules mean minimal work is required and there is no tuning to be done. The antenna can be as simple as a 31mm length of un-shielded stiff wire or another antenna can be connected remotely via co-ax cable. An antenna such as our K198 2.4GHz TX / RX ANTENNA KIT can be added. This antenna kit will increase the range of the K229.
The K198 is a 2.4Ghz antenna printed on a circuit board, it has been tested with our previous A/V TX/RX kit and gave good a good image at over 100M. These kits are designed to operate from a 9VDC supply.

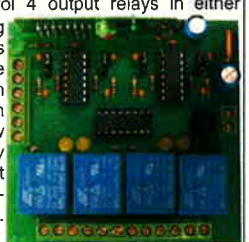
12-24V Dual Battery Adapter for a vehicle.

This kit simply switches an Auxiliary battery across the main battery only when the main battery is fully charged. It will only then charge the second battery. When the battery voltage drops the k227 will isolate the batteries to stop over-discharging of the primary battery. The kit includes all onboard components, PCB and an 80A single coil Latching relay. (K227) $19



4-CHANNEL UHF RECEIVER KIT WITH LIMIT/RESET INPUTS:

This kit is an updated & cheaper version of the original K180 kit. It is still a 4-channel UHF remote control with individual limit / reset input for each channel but without the "code hopping". Uses a pre-built and pre-aligned 433MHz UHF receiver module (RX7) (sold separately $11). Combined with our Series V Transmitter (TX7), this kit can control 4 output relays in either momentary or latching operation. Features include high security, range of ~100m, on-board high current relays with indicator LEDs, and screw terminals for easy connection. Receiver kit includes PCB and all on-board components. (K180B) $33



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SERVICEMAN'S LOG

I hate servicing rear-projection sets

I have rather a mixed bag this month, ranging from rear-projection TV sets to a surround sound receiver. There's also a story on what happens if you lose the PIN to your car radio.

I hate servicing rear projection TVs. It's not because they aren't interesting. Rather, it's because 90% of the repair is spent in the logistics of handling their enormous bulk and because, until recently, their performance was rather "ho hum" (although that's changed in the last few years), their main advantage being their large picture.

I positively refuse to do in-house service unless it is only a fuse or installation problem. After all, the chassis is at the very bottom of these monoliths and access is usually quite difficult. What's more, there are usually about one million screws holding the chassis so it won't fall the few centimetres it is above the ground and smash into a thousand pieces all over the floor.

To make matters even more difficult, the PC board tracks are on the underside of the chassis – at least in a car you can lie on a trolley and wheel yourself underneath or raise it on a hoist!

An ailing Sony

Anyway, Mr Hodges 1996 Sony KPE41SN11 rear projection set (RG-1 chassis) was in the process of failing to proceed. Intermittently, the picture was slowly getting duller and now there was no vertical deflection. This latter fault can often be extremely serious because if the protection circuit doesn't cut in, screen burn will result in just a few seconds and ruin the expensive picture tube. This time, we were saved because the picture was so dull.

Because of the possible danger to the individual tubes, I decide to tackle the vertical deflection problem first. On normal TV sets, the vertical output IC is usually located not far from the line output stage and flyback transformer. And because the service manual for this set was on order, I thought I would have a crack at it blind.

I began by "wedging" the projector between the ceiling and the top of my work bench (it's possible I might be exaggerating just a little here – but you get my drift!). And because it took up so much space, my soldering iron and all other tools had to be moved onto nearby stools.

Even after removing the million or so screws (again, I might be exaggerating a little), it was extremely difficult to edge the chassis out, as the cable harness is tied down tightly to the cabinet in several places. In the end, I gave up and instead decided to remove the board with the flyback transformer (I later discovered that this is the E Board).

This was a bad choice as it didn't really have anything to do with the vertical output. However, having removed it, I resoldered a few potential dry joints and checked the fusible resistors and anything else that looked as though it might throw a spanner into the works. I then refitted the board and moved along to the next on the right – the A board. In fact, on later models, this is the board with the vertical output IC.

Removing this board wasn't easy. First, another one million screws had to be removed and I also had to dissect and remove the AV-inputs board (U) and unplug the processor board B which fits across the A Board. This was tricky for two reasons: (1) there was no headroom; and (2) it was fastened to a sub-frame that had to be unscrewed, not to mention that the main plug had a child-proof lock on it which I couldn't work out.

Eventually, however, with the aid of a lot of muttered words like "bother" and "drat", I managed to force the boards out, only to discover that what I thought was the vertical IC was in fact the sound output IC. Again, I resoldered everything and then spent a large part of what was left of the rest of my life putting it all back together again.

By now, the 140-page Service Manual had arrived and I soon discovered on page 79 that the vertical IC (IC1501, STV9379) was on Board D, somewhere near the front of the set. And so I stuffed the main chassis back into the case and turned the workshop around to get to the front of the set.

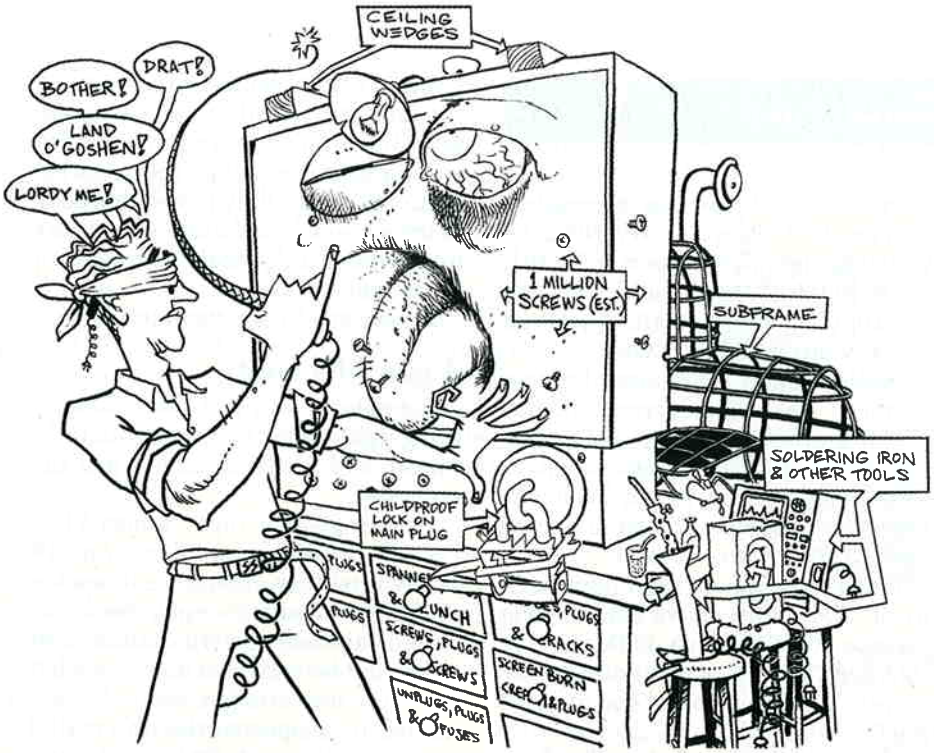
The D Board turned out to be on the floor pan, behind the HA Board and just in front of the three CRTs. Fortunately, this board is quite easy to move. Once again, I checked for dry joints and also fuses F1601 and F1602 and fusible resistors R1519 and R1520 which supply the ±15V to the IC. Unfortunately, nothing looked crook, although that was the way I was starting to feel.

Anyway, I replaced the board and switched the set on to find that it was now dead, with just the front LED flashing. So what had I done?

It was time for a new tack – when in doubt, measure the B+ but honestly, why don't I follow my own advice sooner rather than later! This was a good move because the ±135V rails were way down to just over ±100V.

Items Covered This Month

- Sony KPE41SN11 rear projection TV set (RG-1 chassis)
- Toshiba 43N9UXE rear projection TV set (S99SS chassis)
- Panasonic TX43P250 rear projection TV set (EURO-7VP chassis)
- Pioneer VSX-D503S 110W Surround Sound AV receiver
- Lost PIN For A Car Radio



I THOUGHT I'D HAVE A CRACK AT IT BLIND...

There was a good chance this was where the fault lay. I removed the board and worked on it separately on the kitchen table.

Next, I removed plugs CN6011 and CN6009 on the power supply board (board G) to eliminate any possible loading effects and hung a 100W globe across the positive rail. It was still low, however, and even the ±15V rails were low, which probably accounted for the set's lack of vertical deflection.

A few checks showed that the correct voltages were being fed into the board and the "sub power supply" (STBY) was OK too. I then checked the +135V feedback via IC6008 (SE135N) and optocoupler IC6006 and this was also OK.

It took another eon of time for me to finally discover that the culprit was 270kΩ (4W) resistor R6010, which had gone high to the base of Q6001 (RECT OUIT SENC SW). This was surprising, as it is in series with another 270kΩ resistor (R6009) which was perfectly OK from the main +330V rail from the bridge rectifier. However, this biases the drive to Q6009 and the drive control to IC6009 via optocoupler IC6005.

Anyway, this actually fixed all the symptoms this set had and the picture and sound were pretty good. I really earned my money on this one!

As a postscript, when I got the manual, I also received a Sony Service Bulletin (AVS167 – 1998) about a fault with this symptom: the "top screen has a brighter band effect noticeable on dark screens". It suggested changing C289 at pin 1 of IC208 on the dreaded B Board from 4.7µF to 22µF (Part No: 1-128-551-11), so at great risk to what was left of my sanity I replaced that component as well.

I do hope that Mr Hodges appreciated my efforts.

Other rear projection sets

Other similar dramas I have had recently with rear projection TV sets mostly concern the same logistics problems. However, the faults were different.

One of the sets involved was a 1999 Toshiba 43N9UXE (S9SS chassis). When the "on" button was pressed, the set would try to come on and you could even hear the rush of static from the EHT. However, that was as far as it would get, the set then shutting down again.

This was eventually isolated to R347 (180kΩ), which had gone high on the

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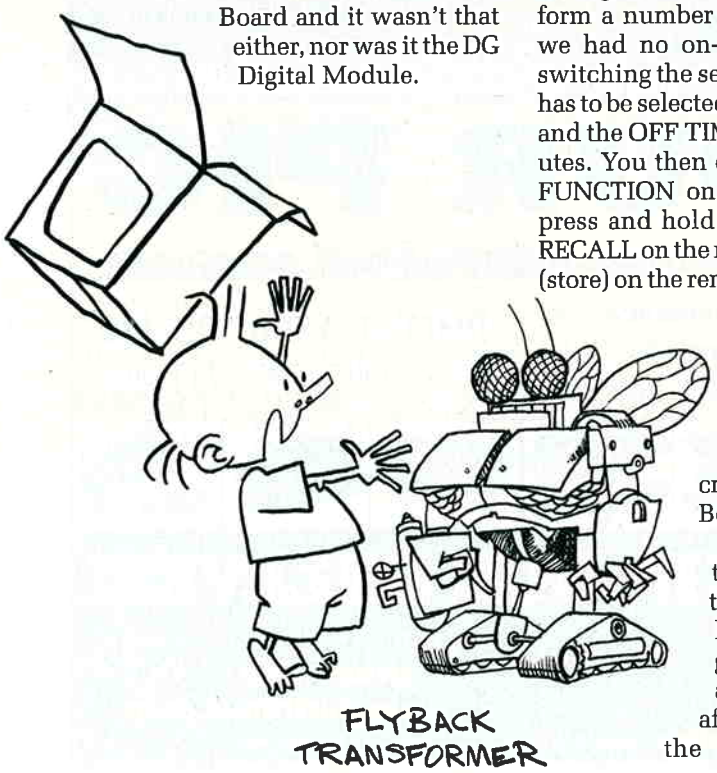
Deflection Board and which feeds a protection circuit involving Q340 and Q341. This circuit monitors the 200V LVP line from the CRTs. In addition, a 36V zener diode (D878) in the 30V power supply for the protection circuit was leaky.

The other set was a 2001 Panasonic TX43P250 (EURO-7VP chassis) with an unusual North-South pincushion correction fault (as opposed to East-West), plus intermittent lack of horizontal synchronisation. Fortunately, we had another identical set in at the time and were able to substitute boards.

This second set had a burn spot on the green tube. A possibility here is that the vertical output IC (IC451) and the two convergence amplifiers (IC7001 & IC7002) had spat the dummy on the D Board but if so, why hadn't the other two tubes been affected? A more likely explanation was that someone had left both the vertical and horizontal deflection yoke outputs disconnected on the green CRT. I have my suspicions.

Getting back to the first Panasonic set, I started with the vertical output and convergence boards, which are the most common areas for failure, but no luck there. Next, I tried the A Board and it wasn't that either, nor was it the DG Digital Module.



Eventually, I found that the problem was on the U Board (TNPA2042AU) which carries microprocessor IC1101, flash ROM (IC1102) and SDRAM (IC1106). The EEPROM (IC1104) is on the A Board which was OK.

I really should have guessed sooner as there was no on-screen display (OSD) and the data was being corrupted. Unfortunately, this expensive little module is no longer available, however hopefully it was only the flash ROM that was at fault.

Being a Panasonic agent, our technical officer told us we could either replace the 8M-Flash ROM IC1102 (marked TV RJ646-4 on a white label), or he could come around and upgrade the firmware.

We settled on the latter. The firmware upgrade deletes the flash settings (which are the non-specific model information such as aspect ratio, progressive scan, SD/HD options, etc) and then reloads the default values. The geometry and convergence settings and levels are kept in the EEPROM.

Anyway, to do this, the set has to be put in the service mode and a special interface from a notebook computer connected to composite video inputs AV2 and AV4 on the rear of the set.

To get the set ready, we had to perform a number of functions blind as we had no on-screen display. After switching the set on, the SETUP mode has to be selected on the remote control and the OFF TIMER set ON to 15 minutes. You then exit SETUP and press FUNCTION on the TV. Finally, you press and hold VOL- on the TV and RECALL on the remote, then press STR (store) on the remote until you can hear the relay click in.

This relay switches the AV2 and AV4 inputs to allow serial DATA directly into the main microprocessor on the U Board.

That done, we ran the upgrade utility on the computer which at least tells you what's going on. This took about five minutes, after which we switched the set off and then on again. It came back on with a perfect picture and sound, so the upgrade fixed the problem – well, nearly. Ten minutes later, the picture began tearing again but we audibly traced this back to the flyback transformer which was intermittent and probably the cause of the whole problem.

A new one finally fixed it.

A cow of a fault

Sometimes you just can't do anything right! Dave, our ace audio technician, had a cow of a fault just the other day.

He was given a 1994 Pioneer VSX-D503S 110W surround sound AV receiver with an intermittent crackle in the left channel to repair. Now, our Dave is normally a very cautious sort of guy but he reckoned he knew what the fault was straight away. In particular, he suspected the differential input transistor pair Q01 & Q03 in the power amplifier stage. After all, the fault was independent of the volume control setting, which ruled out the preamp stages.

Being a caring type, he usually uses a cotton bud which he sprays with freezer and then just touches the suspect component. However, on this occasion, he must have been having a bad hair day – not that he has much left! Anyway, he hit the transistors directly with the freezer. Well, oops – output transistors Q1 and Q3 lost their bottle and failed instantly. He replaced them and the differential input transistors and when he switched it back on, it was fixed. However, when he turned it off and then back on again, it wouldn't come on.

Would you believe that the microprocessor had failed? Apparently, this can happen due to transient pulses when the power transistors fail. Data was going in but nothing was coming out. And so a new IC801 costing in excess of $200 was back-ordered (ETA four weeks). When it finally came, Dave fitted it but now found that the protection circuit was cutting in.

After spending yet more time, he found that Q608 was short circuit but the set still refused to fire up after it was replaced. However, he could turn it on by shorting Q604's base to its emitter.

Feeling somewhat cheesed off by now, Dave replaced Q602, Q603, Q604, Q605, Q606 and Q608 to save time and switched on again. However, it wasn't

Dave's day – or even his fortnight! The sound was OK at low volume but at high volume, was distorted in the left channel. He checked this with the CRO and after a lot more time than he would care to admit, he located the little !@#$% – it was R525, a 100Ω resistor which had gone high. This finally fixed the last problem.

The annoying thing was that these were all unrelated different faults, occurring one after the other. I guess the good thing was that at least they happened while he was still fixing it – it would have been much more difficult had they failed during the warranty period.

No wonder the poor bloke is losing his hair!

The next story comes from a mate who works in the automotive industry. I'll let him tell it in his own words.

Lost the PIN?

One of the most annoying features of modern car audio systems is the use of the "PIN" number. Actually, this is a tautology – it really is just "PIN" of course, otherwise you would have a "Personal Identification Number Number".

Anyway, there was a time in the 80s when the high-end model cars from some manufacturers were fitted with the very best audio technology. Some units were very elaborate affairs, with Dolby, 4-channel outputs, graphic equalisers, digital displays and more buttons than the control console on the Space Shuttle. Remember, this was 20 years ago!

Problem was, because they were so good, they attracted low-life car thieves with amazing regularity. The security systems on cars back then were almost non-existent and most vehicles could be entered using a comb or a piece of plastic tie-strap. And quite often, the thieves did more damage to the car, especially to the dash facia, while removing the audio gear than the gear itself was worth.

In many cases, the gear was literally hacked (or even chopped) out.

To prevent this, the manufacturers introduced the idea of a security PIN for their top-line audio units. This was very effective – as soon as the 12V (memory) supply was removed, the unit was transformed into an expensive paperweight – unless you had the PIN, that is. If you didn't know the PIN, it was impossible to get the unit working again.

This proved very effective and dramatically reduced the theft of high-end car audio equipment almost overnight. As a result, all the makers jumped on the same bandwagon and PIN systems are now used on even the most basic audio system head units. This and the fact that good-quality new systems can be had for a portion of one week's wages have made car audio theft a redundant industry.

Anyway, this is all background to a problem faced by the writer following the purchase of a secondhand car, a Daewoo Nubira wagon. The car itself suits our situation perfectly – the right size, good performance, equipment, economy, etc – but most importantly of all, the purchase price was too good to pass up.

The standard fare in the audio department was an in-dash AM/FM CD player but unfortunately, the PIN had been misplaced. The reason was quite simple – early

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in the car's life, the CD player gave up the ghost, during the warranty period, so an attempt was made to repair it. However, as with many such units nowadays, the necessary parts were either unavailable or too costly (or both), so a replacement factory unit was fitted and everyone was happy.

Well not quite, the PIN was not recorded by either the dealer or the previous owner, so when we fitted a new battery several years later, we were greeted with deafening silence and the word "Code" flashing on the audio unit's display. Unfortunately, despite a thorough search of the dealer's records and other material, no PIN was to be found – a task made doubly difficult by the fact that the car was originally sold new in WA.

So that was it – the existing unit was literally junk. The only solution was to buy a new head unit, an easy task I hear you say. Well, not so! We needed a new unit to not only receive AM & FM and play the occasional CD but also to suit the dashboard.

It also had to be user-friendly. Many units have multi-coloured, hard-to-decipher fluorescent displays and buttons so small that they cannot be read or easily pressed.

The most common facia colour is now silver, whereas the most common look five years ago was black – not a good look. Without being too old-fashioned, it would also be nice to have a rotary volume knob and large easy-to-find controls for the major functions. Swapping, as I do, from car to car, it is quite often near impossible to turn some unfamiliar units on or off, or tune to a different radio station.

To cut a long story short, a suitable unit (at a suitable price) was eventually found. The next step was the installation.

Without going into detail, the dash-mounting method was very well designed – much better than some of my previous setups where you had to be both a double-jointed contortionist and adept at plastic welding repairs in order to fit a simple car audio head unit.

Wiring is another area where things have improved immensely with time. It's now possible to purchase plug kits that are compatible with the dash harness plugs but some are so unique that they fit only one manufacturer's models and then only from one particular year! It seems that some automotive designers go to great lengths to make otherwise simple tasks overly complex, perhaps for no other reason than to justify their job status within their company!

Anyway, the wiring was straightforward for the most part, with the speaker wiring arranged in four pairs utilising standard colours. Unfortunately, though, we ran into problems with the wiring format for the display dimming.

In the original factory unit, display dimming is achieved with an earth return through a rheostat, with the 12V supplied by the same accessory supply rail that powers the unit. However, without access to the factory wiring schematics, the job was just too difficult. In the end, we had to do away with the dimming feature, as the new unit did not allow for this strange set-up.

With the task now complete, we could sit back and admire both our handiwork and how well the new unit's easy-to-read, large, green display almost perfectly matched the Daewoo's instruments. All this for the princely sum of $150.00, including the plug adaptor kit.

The stacker

Being even more adventurous, we found that the maker of our new system also had available a magazine-style 10-CD stacker that mated perfectly with it. This is where sadness enters our tale. We ordered the stacker but when it arrived, we found that its packing had been tampered with and that the transit screws were missing. The reason given for this by the retailer was that there weren't many of these units left and this one had been "pre-tested". What they didn't tell us was that this unit did not pass the test – the CD stacker failed to "stack" or do anything else bar emit some very odd noises.

We also found that the number of such units left in Australia was just one – this one! Anyway, we now look forward to a 6-week wait, while their "service department" investigates the matter.

Why is it always a long wait when the item in question was needed yesterday as a surprise for Mrs Serviceman's birthday? There's no point investigating this in our own workshop, since we lack the necessary parts and service information – not to mention voiding the warranty.

All we can do is wait and see what happens. **SC**

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PRODUCT SHOWCASE

Low cost tower speakers from Dick Smith Electronics

China is certainly causing drastic changes in consumer electronics items. Products that only recently cost hundreds of dollars are now available at a fraction of the old prices.

These tower speakers from Dick Smith Electronics are a case in point at just $99 for the pair.

When we first saw these speakers and the price, we thought, "Nah, can't be any good". Then we had a listen and have had to think again and the conclusion is that they are, in dinkum Aussie-speak: not bad at all!

OK, so they will not put the local hifi speaker manufacturers out of business; far from it but they sound really quite good for average listening to music or as part of a low-cost home theatre system.

The first clue as to how the cost has been kept down comes when you pick them up – the enclosures are very light at around 10.6kg each. Typical hifi speakers of the same height can easily be three or four times that figure, made up of a much heavier cabinet and heavy drivers.

These tower speakers are made from what appears to be 12mm MDF (medium density fibreboard) finished in black vinyl simulated wood veneer.

They have two 200mm woofers with roll surround and quite reasonably large ferrite magnets. The midrange driver is a closed-back nominal 4-inch unit, again with roll surround while the tweeter is a 1-inch dome unit. The cabinet is ported at the back and the gold-plated speaker terminals can take large speaker leads.

Overall dimensions are 970mm high, 235mm wide and 235mm deep. Nominal impedance is 8Ω.

Frequency response is quoted as 48Hz to 20kHz, with no tolerance (dB) range, while power handling is rated at 20W to 120W. Finally, sensitivity is quoted at 88dB ±2dB, presumably at 1W and with the microphone at 1 metre.

We set the speakers up next to our reference hifi speakers (costing many thousands of dollars – not a fair test really) for a general listening test. Our first reaction was that they sounded quite good on a variety of program material ranging from classic to rock.

Overall frequency balance was good and the response over the whole range was commendably smooth, with the qualifying remark that those thin panels do have a number of resonances which become quite evident if you turn up the wick. Overall efficiency is about average; on a par with the 90dB/1w/1m rating our reference speakers.

We think the rating is a little ambitious though; coupled to a 100W per channel amplifier, they were clearly being over-driven at maximum unclipped powers.

We would say they're fine up to about 70W or so but don't expect them to handle much more without being "found out".

In summary though, they are outstanding value for the money: well-finished and able to give a good account of themselves.

They are available from all Dick Smith Electronics and Powerhouse stores at $99.94 for the pair (Cat. A-3099).

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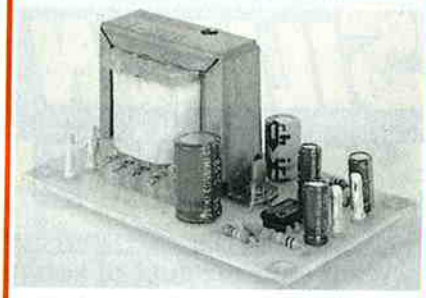

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SpacePort Evaluation Board from RF Modules

The Radiometrix Spaceport Modem Evaluation Kit, available in Australia & NZ from RF Modules Australia, enables SPM/RFM to be transformed into a complete radio modem with direct interface to an RS232 serial port.

Setup and configuration uses HyperTerminal, which also gives access to internal diagnostic/test modes. Each data and control pin is accessible for external interface or testing. An on-board regulator can supply 5V @ 1A to power up DTE.

More information on this, and all Radiometrix products from RF Modules, is available from their website.

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Jaycar's trio of Weather Stations

Is it going to rain on your sporting event, picnic or BBQ? Should you wear a jacket or a T-shirt to the football? Should you water your garden before you go away for the weekend or is it going to rain?

These and many more questions will be answered for you with one of Jaycar Electronics' Weather Stations.

Charting and monitoring the weather is a great project to undertake with the grandchildren, or a healthy and educative school holiday pastime. This is a fantastic way to take an interest in the local environment and learn more about the natural world.

First of the three Jaycar Weather Stations is a stand-alone unit which monitors inside and outside temperature, air pressure, rainfall, humidity, wind speed, wind direction and wind chill factor. The forecast is displayed on the system's screen in an icon style and the barometric pressure trend is displayed as a bar graph so you can see at a glance how fast the pressure is rising or falling. It has a recommended retail price of $249.00 (XC-0293)

The other two models are designed to be connected to a computer (one wirelessly). They include software which will enable you to keep accurate records, almost without limit. The top-of-the-range model has an LCD touch screen. These two models have recommended retail prices of $399 (XC-0291) and $499 (XC-0292)

For more information, visit any Jaycar Electronics store or their website.

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Educational/commercial software from 555

Whether you are looking for electronics-related software for education, for commercial applications or for hobbyist use, there's certain to be something for you in the "New Wave Concepts" range from 555Electronics.

And the best part is that they are priced way under what many other packages cost – yet lose nothing in either application, ease of use or features.

The "flagship" product is Circuit Wizard, combining cicuit design, PC board design, simulations (based on Berkeley SPICE) and CAD/CAM manufacture in one complete package. If you wish, Circuit Wizard will create your PC board pattern for you automatically from the circuits you have designed and simulated!

Other packages in the range include Bright Spark (theory teaching software which combines on-screen animation with realistic simulation); Control Studio 2 (systems modelling software); Livewire (a powerful package for designing and simulating circuits); and PCB Wizard 3.5, an ultra-friendly PC board design package.

One of the biggest advantages of the range is that, once purchased, updates are free during the typical life cycle of 3-5 years (there is no annual fee).

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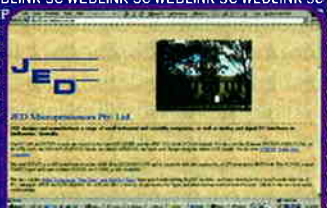

JED designs and manufactures a range of single board computers (based on Wilke Tiger and Atmel AVR), as well as LCD displays and analog and digital I/O for PCs and controllers. JED also makes a PC PROM programmer and RS232/RS485 converters.

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Altronics Melbourne new paint job . . .

Altronics Melbourne store has been open for a few months now but they were so tickled pink about their newly painted exterior they asked us if we could show everyone who reads SILICON CHIP as well . . .

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PICAXE goes colour!

Users of the popular PICAXE Programming Editor software will be interested to know that the latest version automatically 'colour codes' your BASIC programs as it is typed! This makes it much clearer when you have, for instance, typed a correct command as the individual word will change colour instantly. Descriptive 'comments' are also coloured to clearly distinguish them from actual commands.

Other new features include drag & drop editing, automatic indentation for neat program layouts, line number display, and an optional 'split-screen' view to look at two different parts of a program simultaneously. The new software also features a line number 'bookmark' feature - simply right-click to add a 'bookmark' to any line. You can then very quickly jump directly back to this bookmark at any time - very useful when working with long files.

The software update is available to download free of charge from the software page at www.picaxe.co.uk

$60+ off AV Sender – just for joining Radio Parts' Free VIP Club!

Elsewhere in this issue is an invitation from Radio Parts Group to become a VIP member. Membership is free and members are entited to discounted products in the entire product range.

An excellent example of the VIP Member's discount is this very high spec AVS500 /DOSS 2.4GHz Multi-source Wireless AV Sender. Normal retail price is $188.72; VIP Member's price is just $125.81.

With the Multi-Source capabilities of the AVS500, you can watch your cable TV in your living room and a DVD movie in your bedroom. Line-of-sight range is said to be up to 100m.

The dedicated remote control allows you to change the source with the push of the button.

Infrared remote range is up to 40m line-of-sight.

There are four AV-in sources and two AV-out connections.

Other features include:

- Built-in RF modulator on receiver [connect to your TVs aerial terminal]
- 4 selectable channels
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Setup and operation are said to be extremely easy.

Radio Parts will list all VIP Member's prices (as well as recommended retail) in their advertising.

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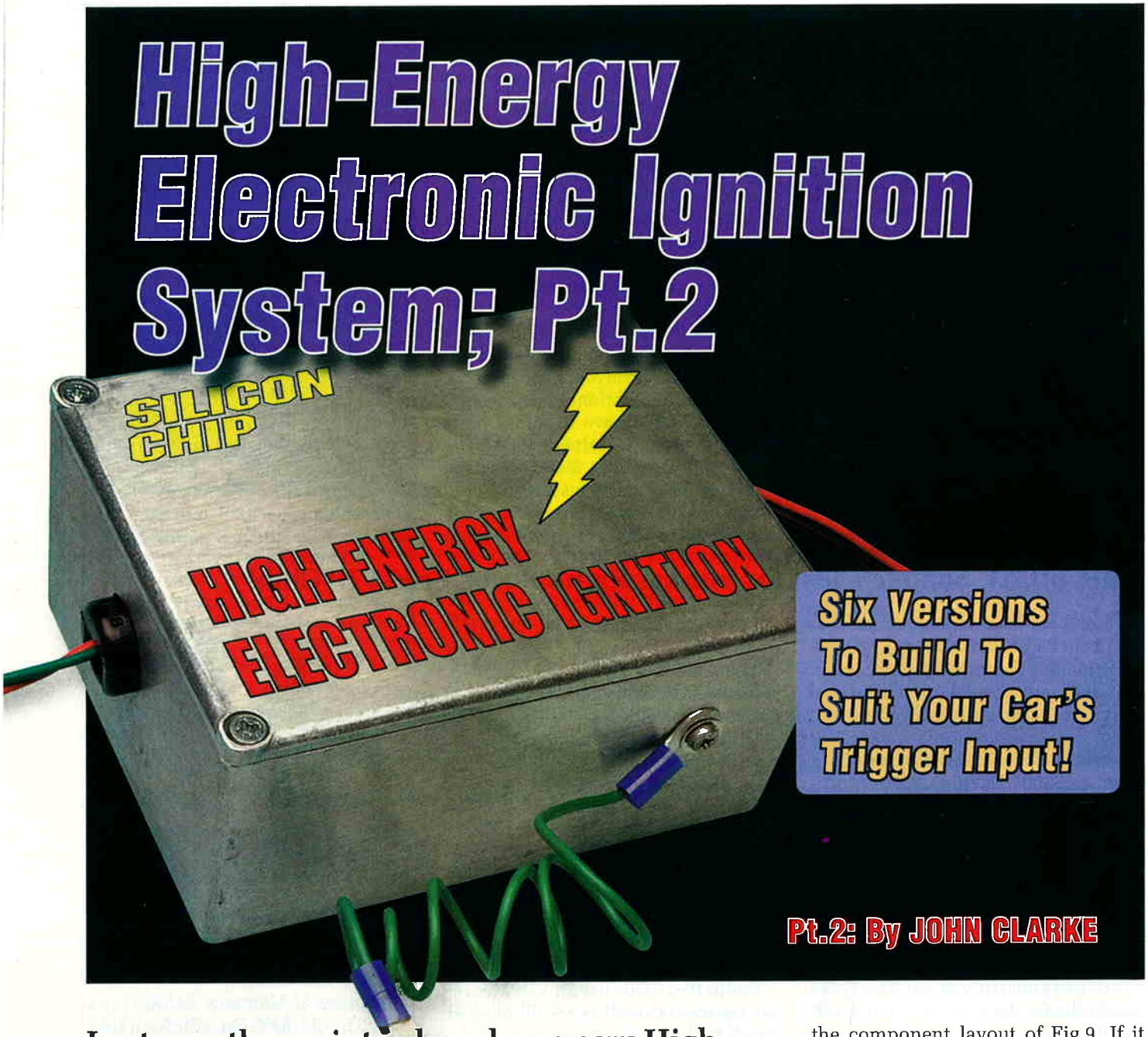
High-Energy Electronic Ignition System; Pt.2



Pt.2: By JOHN CLARKE

Last month, we introduced our new High-Energy Electronic Ignition System and gave the circuit details. This month, we give the assembly details and describe how to convert a points distributor to Hall effect pickup.

THE ELECTRONIC IGNITION is constructed on a PC board that measures 102 x 81mm and is coded 05112051. It is housed in a diecast metal box measuring 119 x 93 x 57mm.

Before installing the parts, check the PC board against the published patterns and make sure that all the holes have been drilled. There should not be any shorts or breaks in the copper tracks. Make repairs if necessary.

Depending on the type of trigger input, there are six different component layouts for the PC board – choose the one that is applicable to your car's trigger sensor. For example, if your car has reluctor distributor, follow the component layout of Fig.9. If it has a Hall Effect device or Lumenition distributor (same thing), use the layout of Fig.10.

Starting construction

Start construction by installing PC stakes at the external wiring points and also insert and solder in the links. The three linking options use 3-way pin headers that are soldered in place. Next, install the resistors, using your multimeter to measure the values.

The zener diodes can go in next. Be sure to install them with the correct orientation. Similarly, make sure that IC1's socket is oriented correctly. Don't insert the IC at this stage, however.

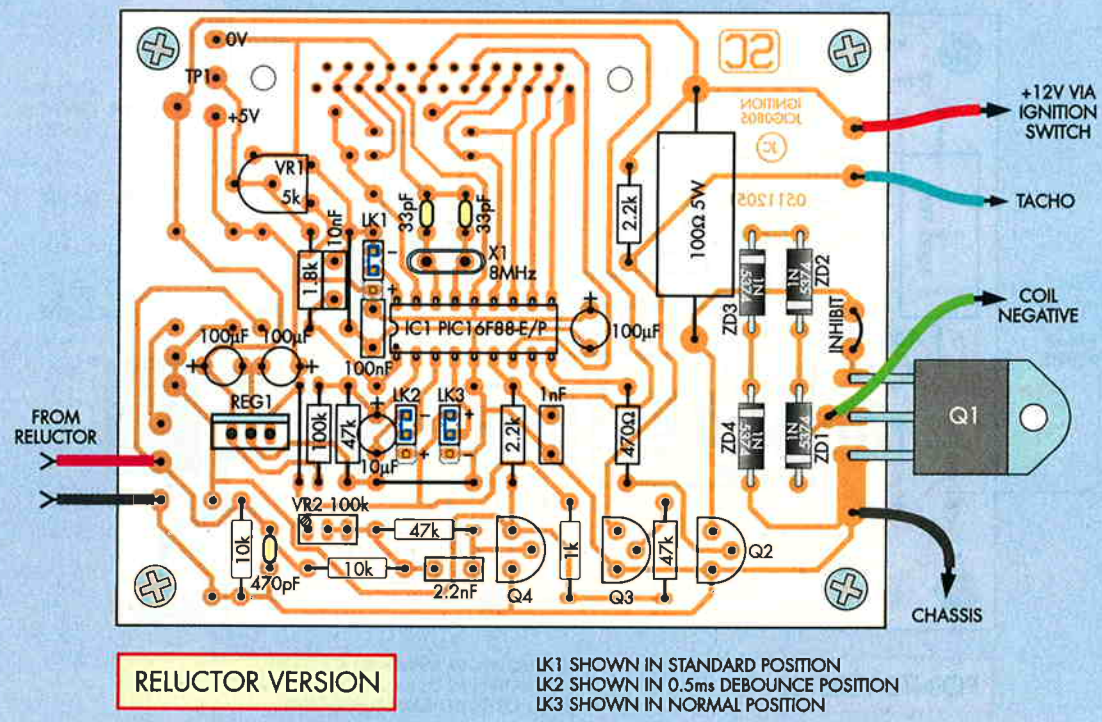


Fig.9: follow this parts layout diagram if your car's distributor has a reluctor pickup.

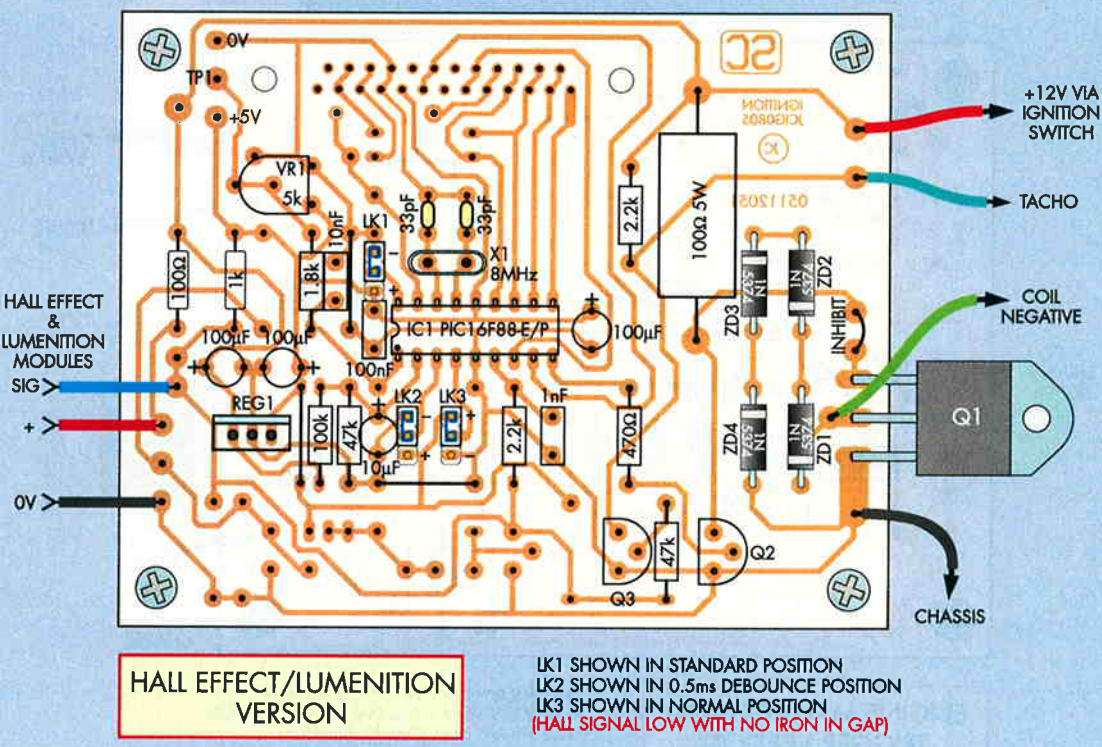


Fig.10: this is the layout to follow if the distributor uses a Hall Effect device or a Lumenition module. Take care with component orientation during assembly.

The transistors are next on the list. Again, make sure they are oriented correctly. Q1 is mounted at full lead length, with its metal flange toward the edge of the PC board.

The capacitors can be installed next. Each electrolytic type must be installed with the polarity indicated. That done, install the crystal and trimpot(s).

Once the board assembly is complete, position it in the case and mark out the four mounting holes. That done, remove the PC board and drill the mounting holes to 3mm. Deburr

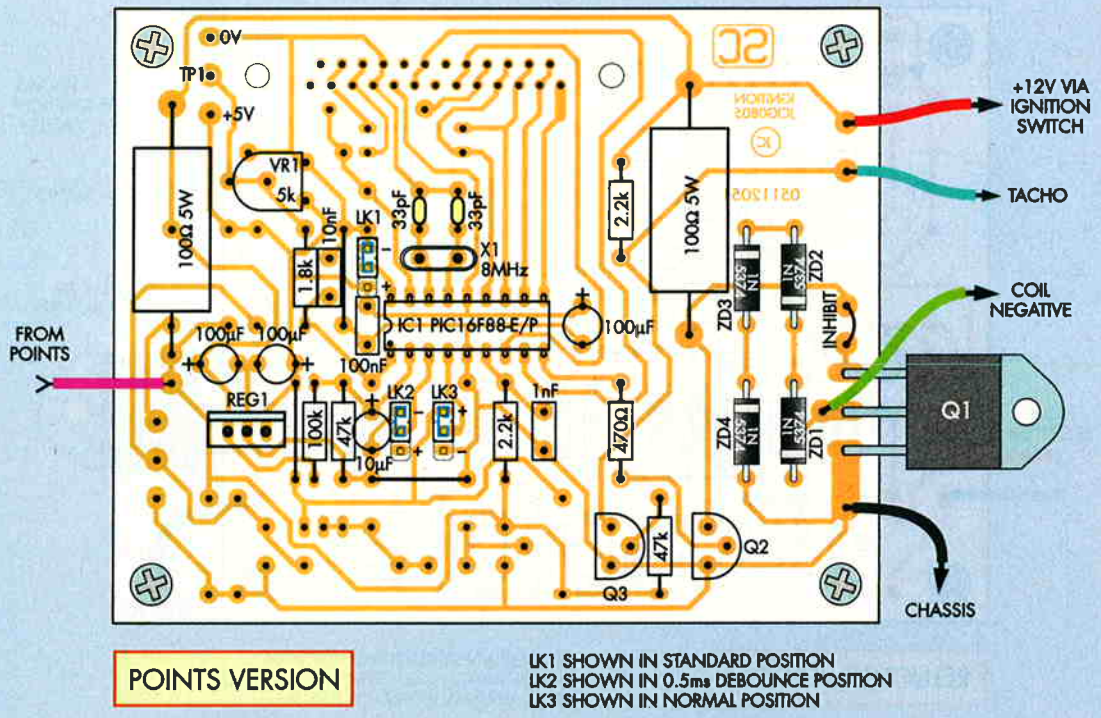


Fig.11: this is the points version. Secure the 100Ω 5W resistors to the board using silicone, to prevent them from vibrating and fracturing their leads and/or the solder joints.

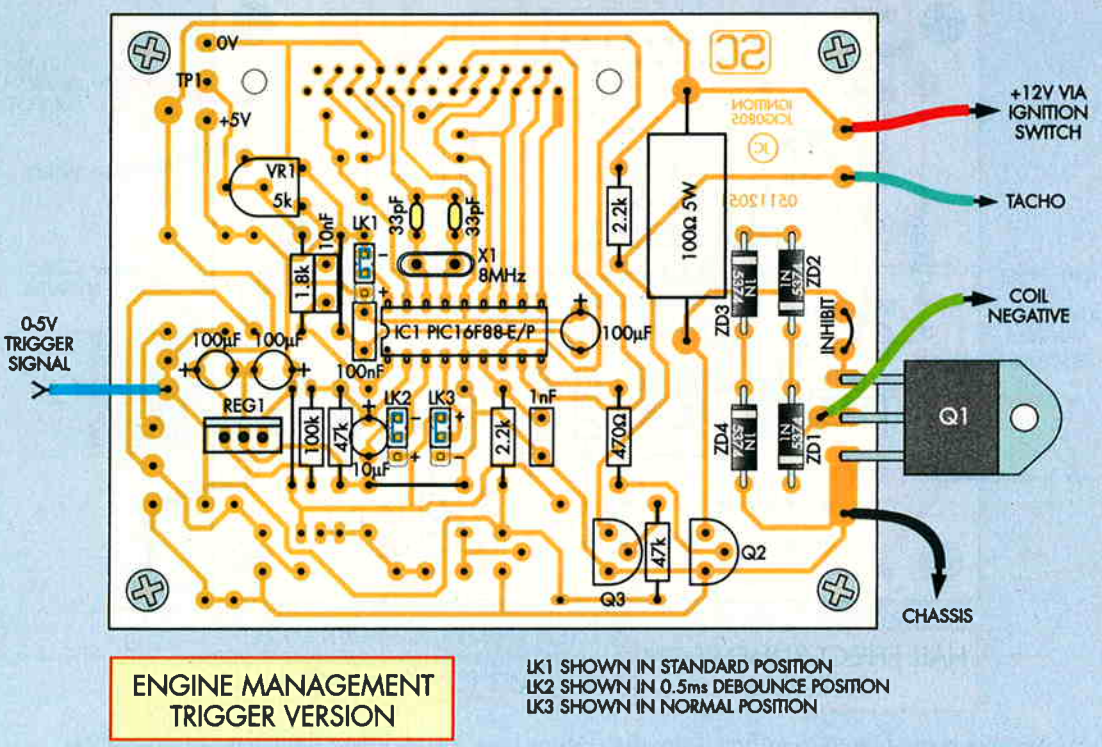


Fig.12: the engine management trigger version requires no additional input conditioning circuitry. In this case, the ECU trigger signal goes straight to pin 6 of IC1 via a 2.2kΩ resistor.

each hole using an oversize drill bit, then fit a 9mm standoff to each mounting position with an M3 x 15mm screw passing through it from outside the case. The PC board is then fitted in place and temporarily secured using M3 washers and nuts.

That done, mark out the position for Q1's mounting hole, the earth connection on the side of the case and the cordgrip grommets at each end of the case, then remove the board

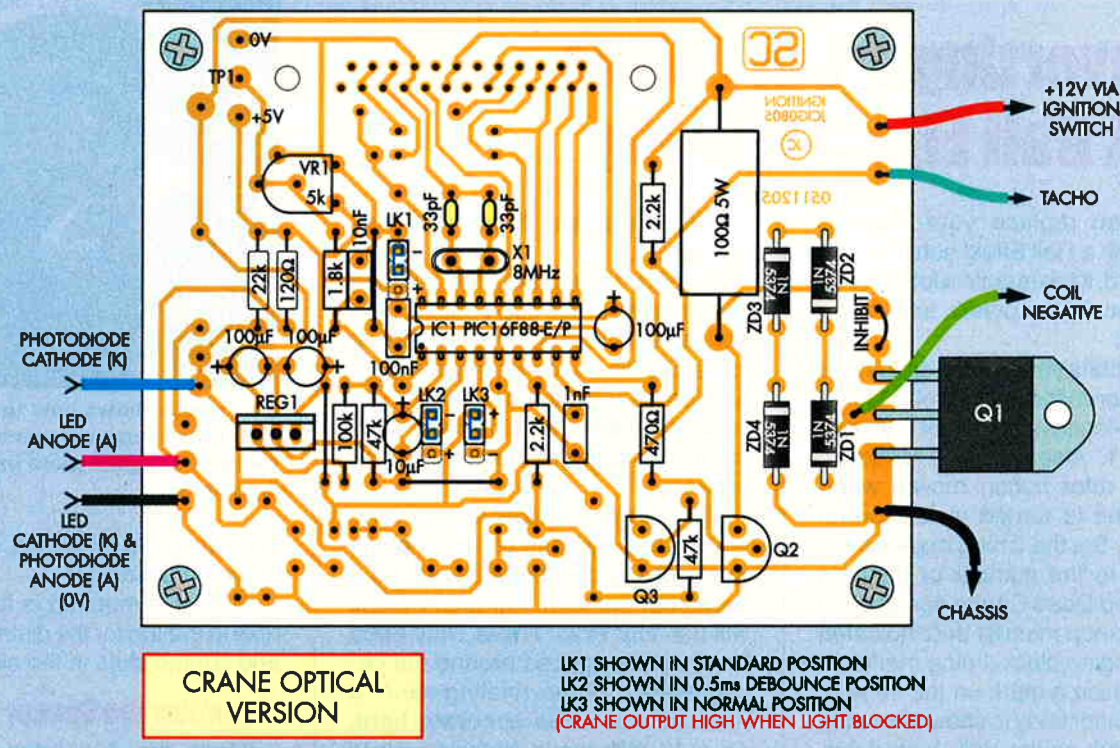


Fig.13: build this version if your distributor has been fitted with a Crane optical pickup.

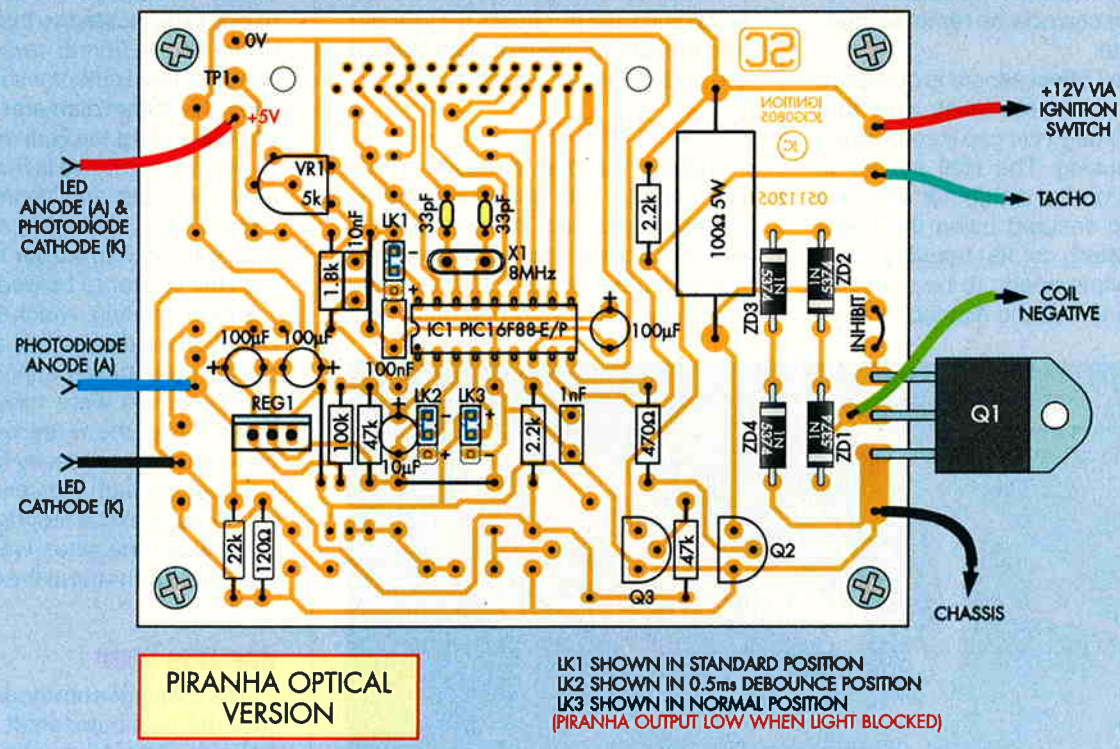


Fig.14: the Piranha optical pickup version is similar to the Crane version but note the different locations for the 22kΩ and 120Ω resistors.

and drill these holes. Note that the cordgrip grommets need elongated holes and these can be shaped using a rat-tailed file.

The inside of the mounting hole for Q1 must be carefully deburred to remove any sharp edges that may puncture the insulating washer. A large diameter drill can be used by hand to do this. That done, you can then install the PC board and secure it using the star washers and nuts.

Converting From Points To A Hall Effect Sensor

You can replace your existing points with a Hall Effect sensor – but be warned, it takes quite a lot of precision work! All the details are shown in Fig.12.

First, rotate your engine so that the rotor button in the distributor is facing the high-tension outlet for cylinder number 1. Also note the direction that the rotor button moves when the engine is turned in its correct direction. Set the timing mark on the flywheel to the number of degrees before Top Dead Centre specified in the workshop manual and indicated by the engine block timing marks.

Now place a mark on the edge of the distributor body to show where the timing mark on the rotor button arm is positioned. This sets the alignment for the Hall Effect modification. The distributor can now be removed from the engine.

The Hall Effect sensor is designed to be used with a rotating vane that passes through the gap incorporated in its housing. The Hall sensor is mounted on the distributor advance plate and secured using the rivets incorporated on its housing. The rotating vane needs to be made so that it spins with the distributor shaft and its vanes pass through the sensor gap.

For this to happen, the rotating vane needs to be cup-shaped. The horizontal face has a hole to allow it to be placed on the distributor shaft and locate with the rotor button. The vertical section needs to have slots cut in it to appropriately trigger the sensor.

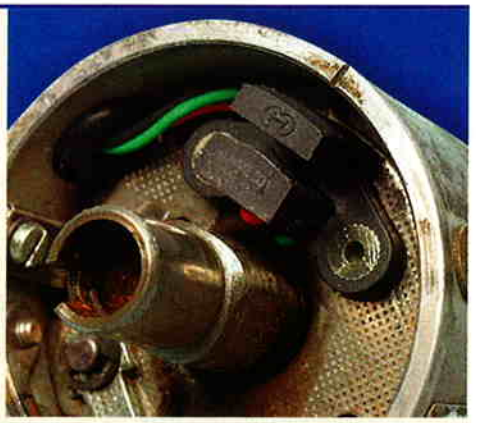
The number of slots on the vane equals the number of spark-plugs for which the distributor caters. So a 4-cylinder car with four spark plugs will use four slots. These slots need to be evenly spaced around the circumference of the rotating vane. **It is essential to be accurate here, as a 1° difference between slots represents 2° on the engine.**

A 4-cylinder engine will have each slot positioned 90° apart. 6-cyclinder and V8 cars will require slots spaced 60° and 45° apart, respectively.

Making The Disk

Making the disk is easier if you can start off with something that is already preformed. We used the tin-plated backing from a high power potentiometer. A suitable one is the Jaycar RP-3975 15W potentiometer.

The rotor button assembly fits over the distributor's camshaft, with the vanes passing through the Hall Effect sensor.



This photo shows how the slotted Hall Effect sensor is rivetted to the vacuum advance plate inside the distributor.

This provides us with a cup that is 40mm in diameter.

All that is required is to drill out a hole in the top for the distributor shaft and cut the slots in the side.

Mounting The Sensor

When this has been done, the Hall sensor can be mounted on the distributor advance plate. The sensor needs to be located so that the centre of its slot is 20mm away from the centre of the distributor shaft. This will allow the 40mm diameter cup to spin without fouling the Hall sensor.

Drill the two holes in the distributor advance plate and countersink the holes on the underside of the plate. This will allow space for the rivets in the Hall sensor to be peened over.

Before riveting, check that the Hall Effect wires do not foul against the points cam (this happened in the distributor we were modifying!). To prevent this, the wires were passed under the Hall sensor by filing a small channel beneath the sensor, so that the wires could be fed through to the other side. The wires were then fed through a grommet in the distributor's body.

Rotating Vane

The rotating vane should be placed over the distributor shaft and should sit on the top of the points camshaft. Check that there is sufficient clearance between the vanes and Hall sensor gap. If the cup needs to be higher than this, it can be placed over the rotor button shaft.

In this case, the rotating vane must be electrically connected to the dis-

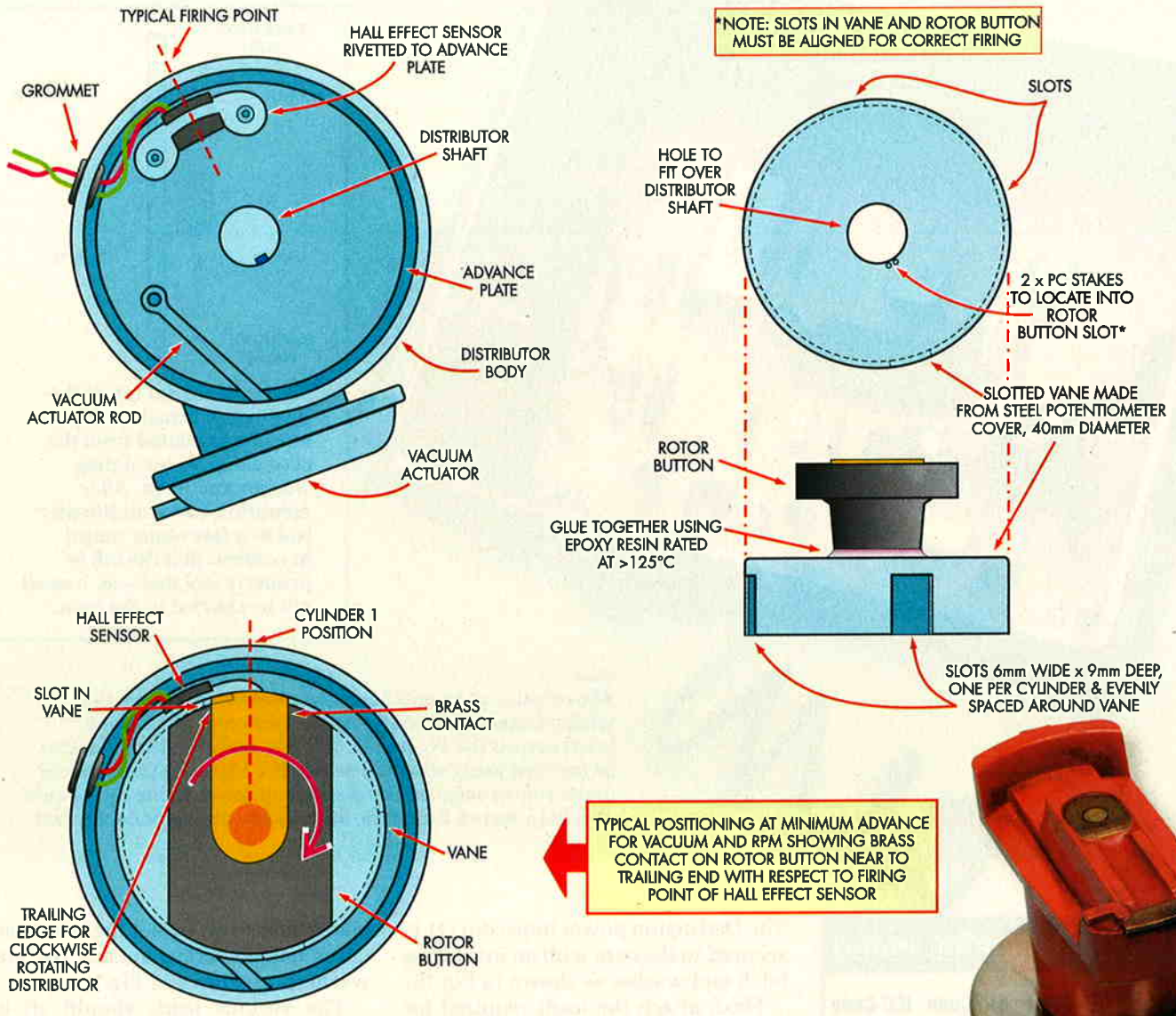

TYPICAL FIRING POINT
HALL EFFECT SENSOR RIVETTED TO ADVANCE PLATE
GROMMET
DISTRIBUTOR SHAFT
ADVANCE PLATE
DISTRIBUTOR BODY
VACUUM ACTUATOR ROD
VACUUM ACTUATOR
*NOTE: SLOTS IN VANE AND ROTOR BUTTON MUST BE ALIGNED FOR CORRECT FIRING
SLOTS
HOLE TO FIT OVER DISTRIBUTOR SHAFT
2 x PC STAKES TO LOCATE INTO ROTOR BUTTON SLOT*
SLOTTED VANE MADE FROM STEEL POTENTIOMETER COVER, 40mm DIAMETER
ROTOR BUTTON
GLUE TOGETHER USING EPOXY RESIN RATED AT >125°C
SLOTS 6mm WIDE x 9mm DEEP, ONE PER CYLINDER & EVENLY SPACED AROUND VANE
HALL EFFECT SENSOR
CYLINDER 1 POSITION
SLOT IN VANE
BRASS CONTACT
VANE
TRAILING EDGE FOR CLOCKWISE ROTATING DISTRIBUTOR
ROTOR BUTTON
TYPICAL POSITIONING AT MINIMUM ADVANCE FOR VACUUM AND RPM SHOWING BRASS CONTACT ON ROTOR BUTTON NEAR TO TRAILING END WITH RESPECT TO FIRING POINT OF HALL EFFECT SENSOR

Fig.15: these diagrams and the accompanying photos show how to replace the points with a Hall Effect sensor and make the rotating vane assembly. Note that the slots in the vane must be accurately positioned – see text.

tributor shaft to prevent static build up which may damage the Hall sensor. A small piece of tinplate soldered to the vane and bent so it passes up inside the rotor button to make contact with the distributor shaft is suitable.

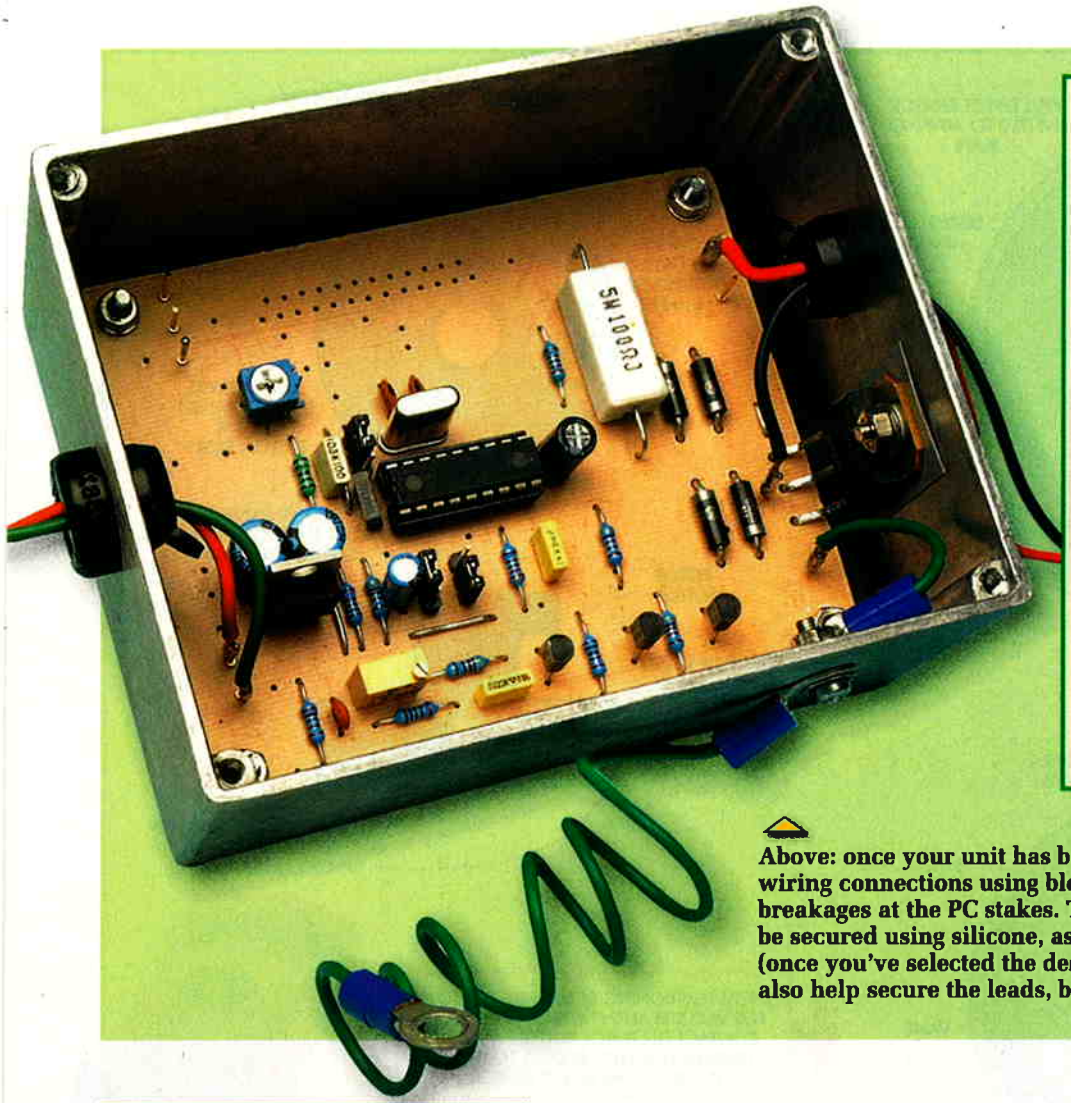
When the Hall Effect sensor has been mounted, place the rotating cup over the distributor shaft and hold it in place with the rotor button. Check that the vane spins freely through the Hall sensor slot.

Now you are ready to align the disk. Rotate the rotor button to the alignment marks set previously. Remember, these indicate the centre position of the rotor button at Number 1 cylinder timing. Move the rotating vane relative to the rotor button so that the gap is just leaving the centre of the Hall Effect sensor.

Note that you must be turning the distributor in the direction that it travels when installed in the car. Mark the position on the rotating vane and rotor button using a marking pen (do not use a scriber on the rotor button or the high tension voltage may travel down this). We soldered in a couple of PC stakes inserted into holes drilled in the top of the vane, to align the vane position – these keyed into the locating slot in the rotor button.

Gluing The Vane

Finally, the rotating vane can be glued to the bottom of the rotor button using high-temperature epoxy resin. We used JB Weld epoxy steel resin, a 2-part epoxy. This is suitable for temperatures of up to 260°C. The quick-setting version can be used for temperatrures up to 150°C.



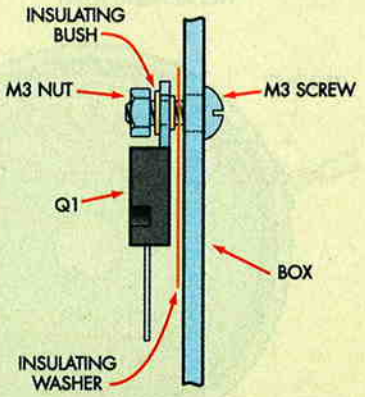


Fig.16: the metal tab of the Darlington transistor (Q1) must be insulated from the case using an insulating washer and bush. After mounting, use a multimeter (set to a low ohms range) to confirm that the tab is properly isolated – ie, it must not be shorted to the case.

Above: once your unit has been assembled, secure the wiring connections using blobs of silicone, to prevent breakages at the PC stakes. The 5W resistor(s) should also be secured using silicone, as can the LK1-LK3 pin headers (once you've selected the desired options). Cable ties should also help secure the leads, both inside and outside the case.

Table 2: Capacitor Codes

Value	µF Code	EIA Code	IEC Code
100nF	0.1µF	104	100nF
10nF	.01µF	103	10nF
1nF	.001µF	102	1nF
2.2nF	.0022µF	222	2n2
470pF	NA	471	470p
33pF	NA	33	33p

The Darlington power transistor Q1 is secured to the case with an insulating bush and washer as shown in Fig.16.

Next, attach the leads required for power, coil and input triggers. Note that the coil wire is the only wire passing through the end cord-grip grommet. The remaining wires pass through the other grommet (ignore the photos) – see Fig.17.

The earth connection from the PC board goes to an eyelet lug that is secured using a screw, nut and two star washers, as shown in Fig.17.

The various leads should all be secured using cable ties, along with beads of silicone at the solder stakes. This is necessary to prevent the leads from vibrating and coming adrift. Similarly, use silicone to secure the 5W resistor(s) to the PC board.

Finally, install the links for LK1,

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	100kΩ	brown black yellow brown	brown black black orange brown
❑	3	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	1	22kΩ	red red orange brown	red red black red brown
❑	2	10kΩ	brown black orange brown	brown black black red brown
❑	2	2.2kΩ	red red red brown	red red black brown brown
❑	1	1.8kΩ	brown grey red brown	brown grey black brown brown
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	1	470Ω	yellow violet brown brown	yellow violet black black brown
❑	1	120Ω	brown red brown brown	brown red black black brown
❑	1	100Ω	brown black brown brown	brown black black black brown

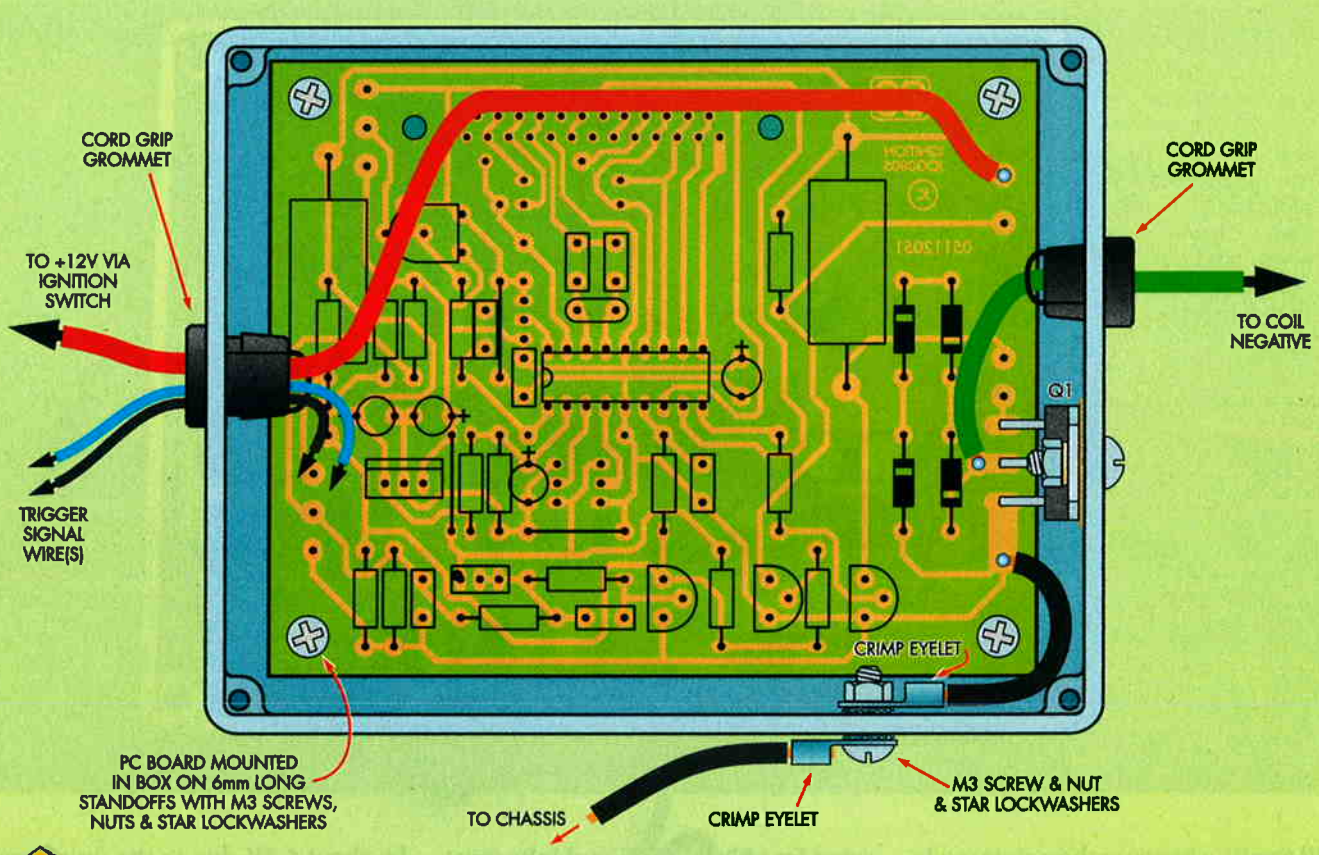
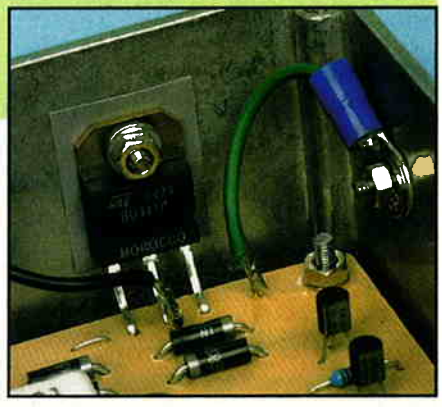

CORD GRIP GROMMET
TO +12V VIA IGNITION SWITCH
TRIGGER SIGNAL WIRE(S)
PC BOARD MOUNTED IN BOX ON 6mm LONG STANDOFFS WITH M3 SCREWS, NUTS & STAR LOCKWASHERS
TO CHASSIS
CRIMP EYELET
M3 SCREW & NUT & STAR LOCKWASHERS
CRIMP EYELET
CORD GRIP GROMMET
TO COIL NEGATIVE
Q1

Fig.17: this diagram shows the final assembly and external wiring details for the unit. Note how the 0V (ground) rail on the PC board is connected to one side of the case, with a lead then run from this point to the vehicle's chassis.



Darlington transistor Q1 is secured to the case using an M3 screw and nut. Make sure its tab is correctly isolated from the case metal – see Fig.16

LK2 and LK3. Initially, you can place these in the standard, 0.5ms debounce and normal positions, respectively.

Installation

The Electronic Ignition box goes in your car's engine bay, on the same side as the distributor. Make sure that the box is shielded from the heat of the exhaust manifold or catalytic converter (the internal components are rated to a maximum temperature of 125°C).

Use brackets and screws to secure the box to the chassis. That done, wire the positive supply lead to the +12V ignition supply, the negative earth lead to the car's chassis and the inputs to the trigger unit. Do not connect to the coil negative yet, however.

Next, set VR1 fully anti-clockwise, then switch on the ignition and check that there is 5V between pins 5 & 14 on the IC socket. If this is correct, switch the ignition off and install IC1. Make sure that it is oriented correctly, with its notch matching the notch at one end of the socket. If you do this incorrectly, you will blow the chip.

Now connect your meter between the 0V PC stake near VR1 and the TP1 PC stake. Switch on and adjust VR1 for a reading of about 4V. This should set the dwell at around 6ms.

Reluctor settings

If you are using the reluctor circuit, adjust VR2 fully clockwise and measure the voltage at pin 6 of IC1. If the voltage is close to 0V, wind VR2 anti-clockwise several turns until the voltage goes to 5V. That done, wind it about two turns more anti-clockwise and leave VR2 at this setting.

If the voltage is 5V when VR2 is fully clockwise, rotate VR2 fully anti-clockwise and start to wind it clockwise until the voltage goes to 5V again. Then wind it two more turns clockwise.

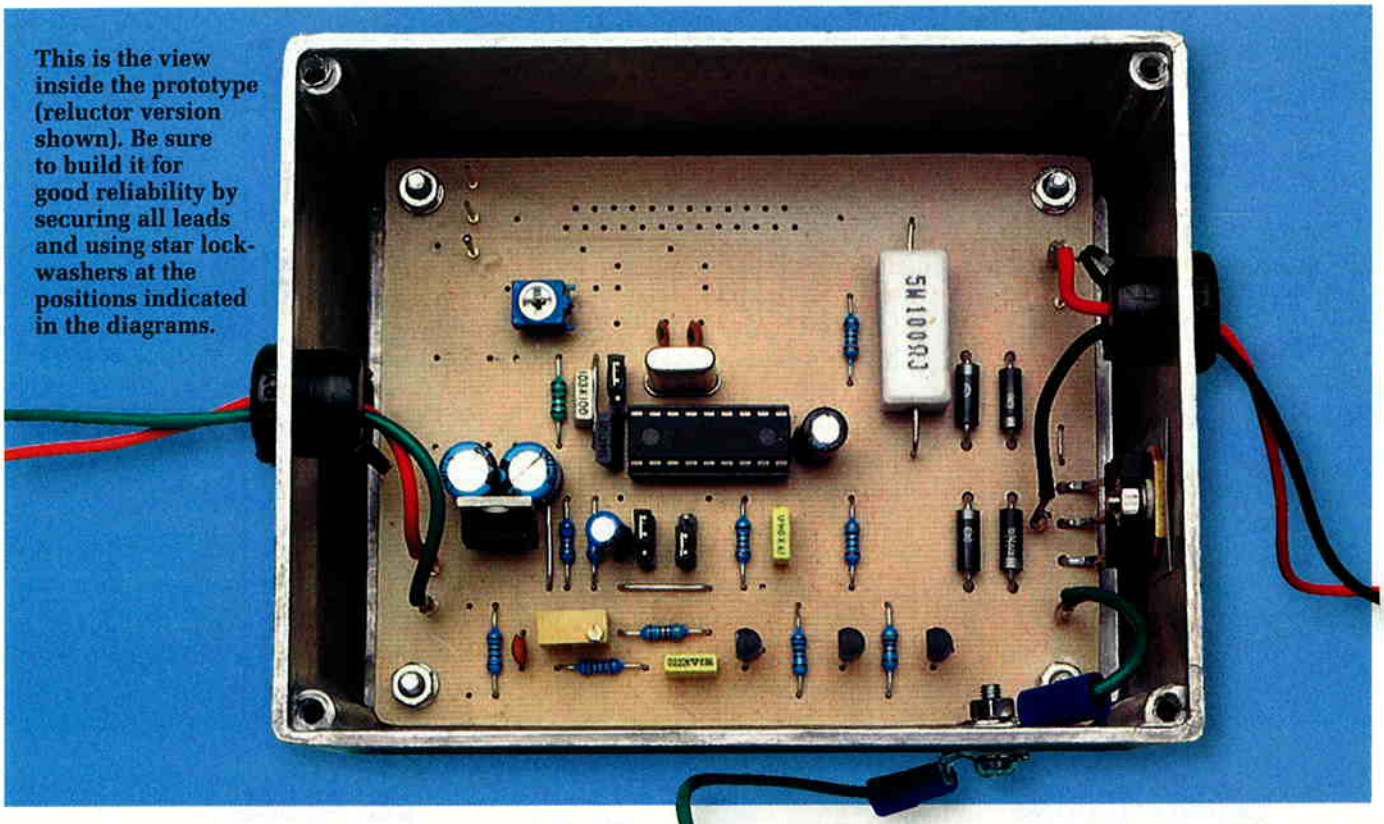
That done, switch off the ignition and connect Q1's collector wire to the ignition coil's negative.

Starting

Now try to start the engine. If it doesn't want to start, the sensor signal may be inverted. This can happen with Hall Effect sensors and optical sensors if the output voltage goes low at the point of firing. In this case, change link LK1 to the "invert" position.

The reluctor circuit is designed to fire the coil when its output voltage swings negative. If the engine doesn't start and you are using a reluctor, try swapping the reluctor connections.

If you are using points and the engine does not run smoothly, try the 2ms debounce link setting. If the engine is



This is the view inside the prototype (reluctor version shown). Be sure to build it for good reliability by securing all leads and using star lock-washers at the positions indicated in the diagrams.

still erratic, change to the points mode using LK3.

Dwell adjust

The amount of dwell required depends on the ignition coil used in your vehicle. To adjust this, set your multimeter to DC volts and connect the probes between the chassis and the negative terminal on the coil.

Danger: you must use a multimeter rated for at least 300V and take great care not to make contact with the negative terminal of the coil!

Set the idle so that the engine runs smoothly and adjust VR1 anti-clockwise until the engine begins to falter or until the voltage reading shown on the meter drops. Now slowly turn VR1 clockwise until the voltage rises and then remains at the same voltage, even though the dwell is increased slightly. Stop turning the trimpot at this voltage plateau. This setting provides the optimum dwell for your coil.

If you wish, you can in fact set the dwell to a slightly greater value than this, to cater for resistance changes at the coil connections due to varying temperatures.

So what did adjusting the pot actually do? What we are doing is measuring the average primary coil voltage. When the coil is charging, the voltage will be about 1.5V due to the drop across the ignition transistor (Q1). When the transistor switches off, there is a high voltage produced that is limited by the zener diodes to 300V. After the coil has discharged, the voltage will be at about 12V (or the battery supply) until transistor Q1 again switches on to recharge the coil. The coil will deliver its full energy if the dwell period is set so that the coil can charge fully.

At this point, the average measured voltage will be at its highest. Increasing the dwell time further will not increase the coil's energy but it may decrease the average measured voltage. This is because the extra dwell will have the coil negative terminal at 1.5V for longer, thus reducing the average measured voltage. Setting more dwell time than necessary will only heat up the coil without improving spark energy.

Once the ignition is set up and running well, fit the lid onto the box.

Conclusion

Depending on the car to which you're fitting the electronic ignition system, you can expect reduced points wear, a stronger spark, a cooler running coil and slightly better fuel economy and power. And that's pretty darn good for the money and time spent! **SC**

Corrections

There are several errors in the parts list published in Pt.1. In the main section, there should be three (not two) 100µF capacitors, the LM2940CT-5 regulator should be designated REG1 and there should be three (not two) crimp eyelets. In addition, the 22Ω resistor listed under the "Optical Pickup Version" heading should in fact be 22kΩ.

Where To Buy Programmed PICs

The programming code (ignition.hex) for the PIC16F88-E/P microcontroller used in this project *will not be released* or be made available on our website. Authorised kitsellers will supply programmed micros as part of their kits.

For people who do not wish to build the project from a kit, programmed micros will be available from SILICON CHIP for $25.00 including postage anywhere within Australia, or $30.00 by airmail elsewhere.

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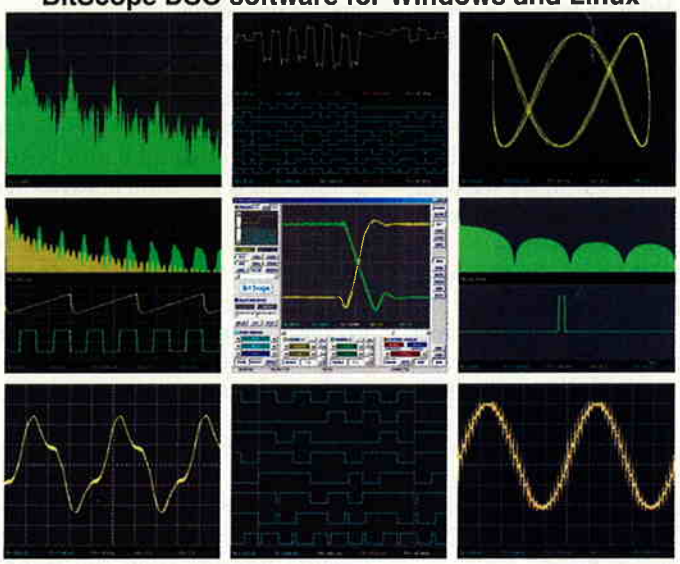

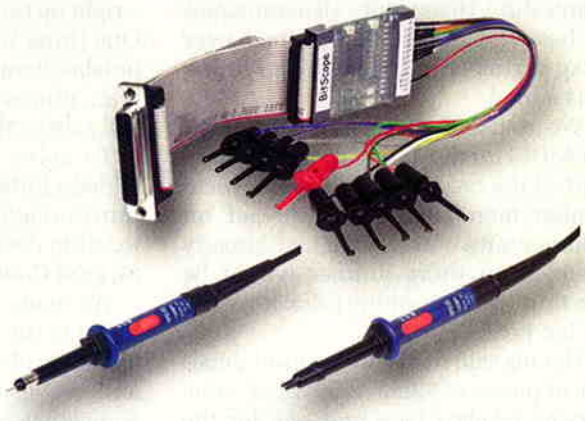

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Building the ULTIMATE

Last month we looked at what we wanted in the Ultimate Jukebox. Now let's start building it . . .

As we explained, the Ultimate Jukebox is actually a powered speaker with a built-in computer running the Ultimate Jukebox software. So all we need to do is come up with a speaker box that will fit an amplifier/power supply and the computer?

That's true – but as the proverb says, there's many a slip twixt cup and lip. For example, we want to make sure our jukebox makes the most economic use of timber. It also needs to be both stable and sturdy enough to take the punishment of its likely environment (let's party!) and it needs to be light enough to move around.

Those last two requirements are actually rather contradictory. To make it stable and sturdy, it needs to be quite heavy duty. Heavy duty also translates as heavy! The final design had over 32kg of timber in it – before anything was added.

We decided on 18mm craftwood (or MDF) for most of the construction. Part of the reason for this is our local timber merchant had a special on 18mm craftwood but we had already decided anything thinner would be too thin while anything thicker would be too heavy.

Having said that, we also used a couple of pieces of 32mm craftwood – one for the jukebox base and one for the computer spacer. More on this anon.

We used two sheets of 1200 x 2500mm 18mm craftwood (as I said, they were cheap!) but one sheet of 2400 x 1200mm will work quite nicely with the sizes we've shown – and leave some change. It's also possible to buy 1200 x 1200mm sheets which are easier to work with (and transport).

Also, ask your timber supplier if they offer a cutting service. If they do, take advantage of it: their cuts are likely to be smoother and squarer than yours (certainly squarer than mine!) and you'll end up with pieces that fit together beautifully.

Even if they charge for the cuts (and most do, with the average charge about $2.00 per cut plus GST), you're going to pay not much more than about $15 for cuts – pretty good value in my humble opinion.

Changes since last month

The Ultimate Jukebox has been a work-in-progress for many months – right up until this issue went to press. One thing we did find was that some notebook computers have more output than others – indeed, some cannot fully drive the SC480 amplifier.

To solve this little problem, we added a little (and cheap!) preamplifier into the signal line. Again, we used an existing design, the PreCHAMP from SILICON CHIP July 1994 issue.

We made a slight adjustment to allow it to run from the +15V supply we already had on the power supply board and we also throttled the gain back somewhat – as originally published, it was simply too much.

Kits for this preamp are still available – in fact, it's a very popular little kit and one to keep in mind if you ever need a general-purpose preamp. Best of all, it sells for just $6.95.

Another change we made was in the port, or vent – and we'll explain this in just a moment.

And finally, we thought that the box lacked something that the "real thing" would have – flashing coloured lights. So we took the easy way out and got some ropelight: presto, instant flashing coloured lights!

The speaker "box"

While the Ultimate Jukebox is all one piece, it's possibly a bit easier to look at it as three components. We'll start with the speaker enclosure.

This is a vented (ported) type with an internal measurement of 600 x 440 x 321mm. That gives it a volume of around 84.5 litres; slightly larger than our "Bass Box" calculations dictated but this can be taken care of by adjusting the port size.

The reason for this larger size, by the way, was twofold: the extra space is basically width and depth, giving better stability, and the dimensions chosen make for the minimum number of cuts in a standard 1200mm craftwood sheet or sheets.

The front, or baffle, is inset 18mm in from the front edge to give some measure of protection to the speaker drivers, even though the woofer is later covered with a metal grille. The baffle slides into a 5mm rebate routed into both sides and the base before the speaker top and notebook spacer are placed.

The woofer mounts on the rear of the baffle while the compression horn tweeter mounts from the front, in a

JUKEBOX

Part 2
by Ross Tester

suitably sized rebate (sizes are shown on the cutting diagrams).

Screwed to the inside of the enclosure is the crossover, with wiring secured to the timber with electrical staples or cable clamps. Don't be tempted to use ordinary staples because they have this nasty little habit of cutting straight through wiring insulation!

Small holes are drilled through the top and bottom of the enclosure to enable cabling to pass through: power to, and audio from, the laptop and of course the output from amplifier to speakers. When the cables are installed, the holes are made airtight with silicon sealant or similar.

The two sides are mirror-image and are 1200 x 375mm. The top of the sides was shaped with a jigsaw into a curve to give a less stark (boxy) appearance. Three 5mm rebates are cut into the sides – these house the bottom (32mm rebate), enclosure bottom (18mm) and finally a 50mm rebate for the enclosure top and notebook spacer.

Larger port

The 900mm x 450mm back of the speaker also mounts into 18mm rebates in the sides and is the last piece of timber placed. It doesn't cover the entire back of the Jukebox because we left a 50mm air gap in the bottom to act as the port.

This is significantly larger than Bass Box suggested would be optimum for the woofer we used but trial and (ear)or said that we ended up with the best sound. Most jukebox users (ie, party goers!) want thumping bass and this large horizontal back-panel port gave us a great sound – far better than tuning for a flat response.

Similarly to the sides, a rebate is cut

into the back to house the enclosure top and the notebook spacer.

The amplifier enclosure

The amplifier "enclosure" at the bottom of the Jukebox contains the amplifier, power supply and notebook/laptop power supply, along with the fused IEC mains inlet, on/off switch and USB disk drive. There is no covering over the amplifier section; the back is open to the air for cooling.

It is significantly larger than necessary – our amplifier heatsink is only 80mm high and we've made the space 200mm high.

The reason (and also the reason for being open to the back) is for ventilation/air circulation – while the amplifier heatsink itself is mounted right at the rear, there is still the transformer giving off heat, not to mention the notebook/laptop power supply which also generates heat.

Also, we said last month that the jukebox was capable of handling a much larger amplifier, so if you want to go this route there is plenty of space to do so.

We mounted our amplifier and power supplies on an aluminium "tray" for ease of assembly (and later service if needed).

The notebook enclosure

Above the speaker enclosure is the space for the notebook/laptop computer. Because we didn't want to allow any access to the keyboard, this is set into a "well" made from a piece of 32mm craftwood, fixed to the outer surface of the speaker box top. Above this again is fixed a sheet of 2mm aluminium which completely covers the keyboard.

The aluminium sheet has a cutout the width of the screen and a depth suitable to allow it to clear.

We actually made ours slightly wider than necessary to give somewhat hidden access to the notebook's power switch. This is something that you might not have to do if your noteboook's BIOS will allow you to boot after power interruption. Then you can simply run the notebook without a battery and allow it to boot whenever the Jukebox is turned on at the mains.

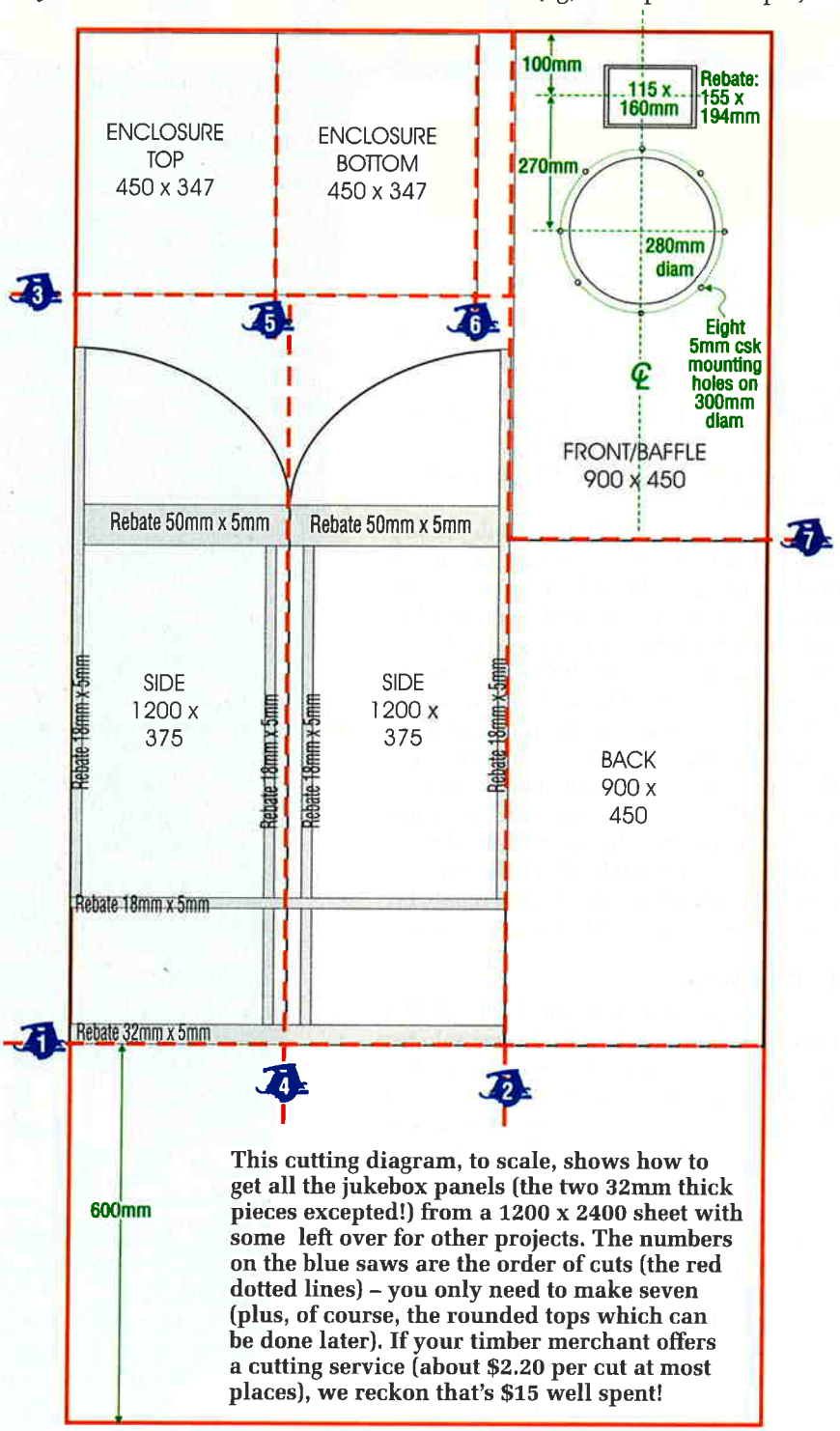
Each laptop/notebook computer will be slightly different and you need to decide if 32mm is enough height to clear the top of the keys – if not, you may need to make the well a little deeper. Conversely, some modern notebooks are very thin, so you might not need 32mm depth.

The other consideration for the computer is heat. Notebooks are not designed to be operated in an enclosed space (hence making the well "U" shaped, allowing air to flow out the back). With the computer we used, the cooling fan is also at the rear, making a "best case" scenario.

If you have trouble with heat, some form of forced air cooling may be necessary (you can buy notebook coolers which could be an answer, albeit at the cost of a deeper "well").

The notebook screen is designed to swing up against the back panel with enough angle to ensure that viewers of normal height don't have to bend down to view it.

That pretty well covers the various parts of the Ultimate Jukebox. We added a few "extras" which we'll get to later (eg, the speaker carpet) but



This cutting diagram, to scale, shows how to get all the jukebox panels (the two 32mm thick pieces excepted!) from a 1200 x 2400 sheet with some left over for other projects. The numbers on the blue saws are the order of cuts (the red dotted lines) – you only need to make seven (plus, of course, the rounded tops which can be done later). If your timber merchant offers a cutting service (about $2.20 per cut at most places), we reckon that's $15 well spent!

now we move on to assembly.

Putting it together

If you've taken our advice and had the pieces sawn by the supplier, you're going to have an easy assembly. If not, and your cuts aren't quite true or perhaps not quite even, it's going to be a bit more difficult.

We found the fit was so good as we assembled the pieces that we didn't even need to cramp the box together as it was glued'n'screwed. Even the rebates (which I will admit I had never done before) came up a treat!

Start by cutting the rounded corners on the top of the sides. We simply used a garbage tin lid to get the curve and then cut them with a jigsaw. A bit of rough sanding removed any blade marks – fine sanding isn't necessary. As long as the curve is true, don't worry too much about getting it absolutely smooth. We're going to cover the box with speaker carpet later and this hides a multitude of "oopses!". (Trust me – I made some).

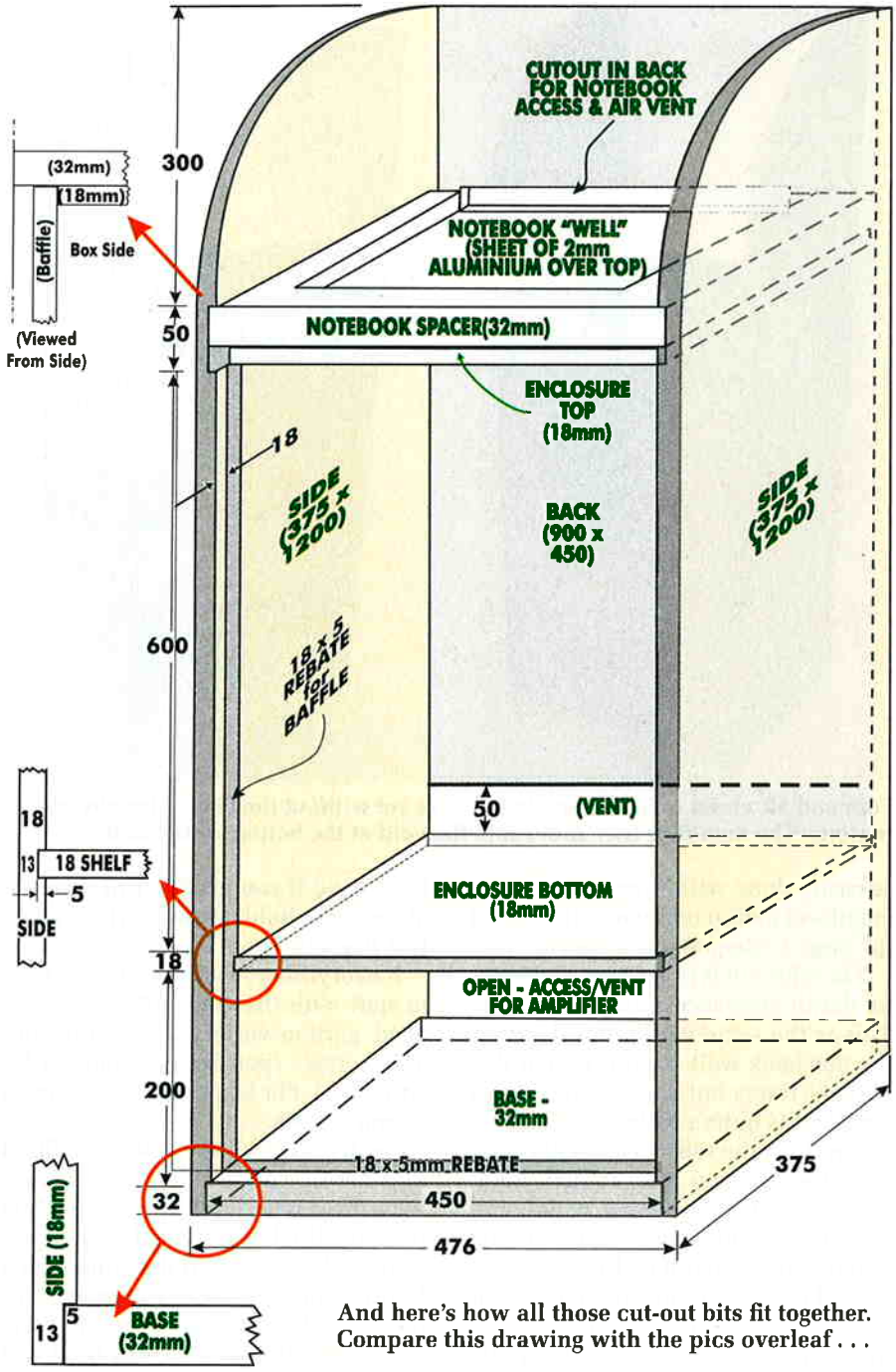
The carpet also hides the majority of the screws used in construction.

The next step, rebating, is probably the most important because it will determine just how well the box fits together. We used a router with a 19mm blade (we couldn't buy an 18mm but the extra millimetre doesn't really matter) and first cut the rebates which went from front to back on the sides (three each side). Of course, the 32mm and 50mm rebates require more than one cut; the 50mm rebate needs two outside cuts then the "meat" removed from the middle.

If it is at all possible, the sides should be clamped side-by-side and the rebates cut across both pieces in one action. That way, you know they are going to line up.

With these cut, we were able to get the right places for the vertical rebates on the sides. The front rebate is inset 18mm while the rear is right on the back. Remember that neither of these rebates goes from top to bottom – the front rebate goes from bottom up to the 50mm horizontal rebate; the back rebate goes from the top down to the 18mm rebate.

A 5mm x 18mm rebate also needs to be cut across the front of the base to match the rebates on the sides (ie, inset 18mm). Because the back panel doesn't come down to the base, no rebate is necessary there.



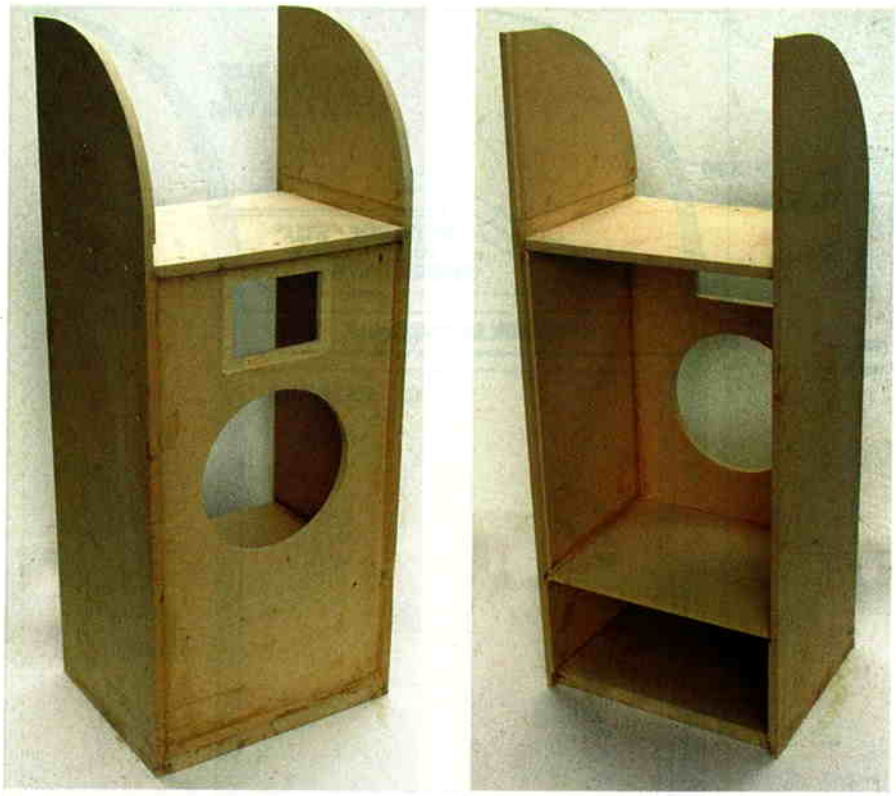
And here's how all those cut-out bits fit together. Compare this drawing with the pics overleaf . . .

While you're in the rebate mood, you might as well cut the two holes for the speaker drivers in the baffle. We used the router mounted on a home-made jig to cut the 280mm circular hole for the woofer and a jig saw to cut the 115 x 160mm hole for the compression driver.

We then used the router once more to cut a rebate in the front side of the baffle for the compression driver so its front finished flush with the baffle front. If you think this is a bit of overkill, don't worry about doing it – there won't be any difference in performance one way or the other.

It makes sense at this point to mark and drill the eight holes for the woofer and six holes for the tweeter. The woofer has 4mm holes which go right through the baffle (it's held in with bolts and nuts) while the tweeter has 2mm pilot holes for the woodscrews which hold it in.

There are two other cuts necessary. One is to make the notebook "well" in the 32mm craftwood – we simply made this as large as we thought would be needed to suit the notebook. In retrospect, we realise this could be just



Fore and aft views of the assembled box, as yet without the back – for obvious reasons. The amplifier tray slides into the void at the bottom of the unit.

as easily done with three appropriate lengths of 32mm craftwood instead of the large U-shaped piece we cut.

The other cut is in the back of the box for the air vent/access to the notebook. This is the same width and depth as the notebook well. Again, we cut this with the router but a jigsaw would also handle this quite nicely.

That's all the rebates and cuts completed – now you need to drill holes in the sides for the screws which will hold it all together. Somewhere around 4-5mm holes should be fine.

Drill the holes along the centre lines of all rebates – we placed screws 50mm in from each edge and then around 150-170mm apart, depending on the length to be covered. Following the rebates means you should end up with holes that are dead centre and will not split when screws are placed.

When all the holes are drilled, turn the sides over and countersink each hole so that all screw heads will end up flush with (or even slightly below) the surface.

Dummy run

Loosely assemble the box (ie, without glue or screws) just to ensure everything goes together as it should. You may need a second pair of hands here – and if you need to nip a couple of screws to hold it together, that's fine. Just don't do them up all the way

If everything looks correct, it's time to start with the glue and screws. We used garden-variety PVA glue and TEK screws specifically intended for chipboard. For box assembly, we used 50mm screws.

As we said before, our box fitted together so well it didn't need cramping – the screws held it securely while the glue dried. If you need to cramp it, so be it. Starting with the sides, run a healthy line of glue in the rebates for the baffle, base and enclosure bottom, stand the sides up, fit the base and enclosure bottom and nip in enough screws (four corners?) to stop it all collapsing.

Place the baffle in place in its rebates (make sure the glue hasn't oozed away) and tighten up the loose screws. Now run a line of glue in the rebate in the speaker top, turn it over and slide it in from the back. Make sure the baffle mates with the rebate and place say four screws to hold the speaker top in position.

At this stage, we also fitted the back to make sure the box stayed square. We didn't bother with all the screws – four hold it sufficiently in place – but whatever you do, don't glue it in place yet!

After checking that everything is still where it should be and that the box is still square, start placing the rest of the screws. You'll find a power screwdriver or cordless drill is almost a necessity here – we used 30 screws in each side.

You'll probably find some of the glue has been forced out of the joins as the panels are tightened up. That's fine – simply use your finger to run a bead of the glue back into the join.

Once all screws are in and tight, put the box aside for a few hours to dry. Then we come to one of the fun parts – applying the carpet!

Speaker carpet

As well as hiding any sins, speaker carpet is also pretty flexible stuff in its own right. It can be pushed, pulled, prodded and stretched to make it cover just about any shape. We didn't have any problems at all fitting it to the curved tops to the Ultimate Jukebox (and curves are the hardest part).

The whole outside of the box is covered in the carpet, with the exception of the notebook well. The only reason I didn't cover this was that the thickness of the carpet would have meant that the 32mm craftwood was just too thin and the notebook keys would be starting to compress.

The aluminium covering above the notebook was covered in speaker carpet on the top (you could cover both sides if you wish).

Contact adhesive secures the speaker carpet to the box. Don't underestimate the amount of glue you will need: I did! I thought a 1-litre tin would be ample – I went through over two litres (the speaker carpet really soaks it up!). With a bit more care, I could have just scraped through with two.

You're also going to need a notched spreader to apply the glue. These are commonly available where contact adhesive is sold – usually right next to it on the shelf!

The easiest way to use contact is to coat the hard surface to be glued, place the carpet on while wet, then separate the two again until they are both just dry ("tacky" is an expression often used). Then carefully place the carpet back onto the surface, stretching it tight as you go. Remember that with contact adhesive, you get just one go!

Plan the covering so that you have

minimum cuts – it just looks better that way. The simplest surfaces to be covered are the sides and back – so if you haven't glued speaker carpet before, this is a fairly risk-free area to develop your skills

Cut a piece of carpet that will do both sides and the back – allow say 10cm for safety. Do each surface in turn – ie, glue one side, attach the carpet, then the back, then the other side. Finally, do the front edges of the sides.

You'll find as you do the curved surface at the top that the carpet can be stretched tight as you go and it should follow the curve without puckering.

You need a very sharp knife to cut the carpet "in situ" – a "Stanley" knife is normally not sharp enough unless you've sharpened it on a whetstone. A craft knife is a much better proposition because they have snap-off blades – as the cutting edge dulls you can snap that bit off and get a new, sharp blade.

Cutting the carpet is as simple as running the blade down the surface where you want to cut. Remember though that the box is timber and your knife is very sharp – sharp enough to cut into the wood. I generally cut using a thin metal rule following the cut under the knife blade to prevent it knicking or slicing into the wood and cutting the carpet off line.

Cut the carpet as you go, so you don't end up with a whole lot of pieces flapping about. This also means you can perhaps extend another piece to cover any "oopses". Because the carpet has a grainy finish, slight imperfections are easy to hide.

Once you have the sides and back finished, you can do the baffle. Remember that this is inset – you need to turn the carpet up at the edges to meet the piece already fitted. You'll find that the carpet can be pressed into the corners easily – I used the back of the craft knife to make a nice, neat corner.

You can now carefully cut out the speaker holes. A long (~880mm) thin (18mm) strip (precut for convenience) can be glued around the woofer cut-out.

All that's left of the box itself is the inside top sides and back – this should be quite easy because by now, you're getting pretty skilled in gluing speaker carpet!

Cutting the back out

The back is currently held in place with four screws . . . and the speaker carpet. And, of course, you need to get the back off so that you can wire the speakers and crossover.

With the craft knife, cut along the seam between the back and rebated sides, then cut a small slit across each of the four screws. That way you can get a screwdriver in and remove the screws – and the back. If the back is such a tight fit that there is no seam to get the knife into, use a long straight edge to cut along where the seam would be. With 18mm timber and a 5mm rebate, that means 13mm in from the edge.

If you get it "pretty" enough, once the back is screwed permanently on you won't even know there's a seam there. If your cut is a bit onky, don't worry too much: it's at the back!

Moving it

At 32kg for the timber alone, the Ultimate Jukebox takes a bit of dragging around. To assist this, we fitted a pair of 40mm castors on the base, at the back. Actual height of these from top to bottom is 85mm.

At the front, we screwed in a length of 100 x 50mm framing timber, planed down to 85mm high, as a "foot" and covered it with speaker carpet.

That way, when let off the wheels, much of the jukebox weight transferred to the timber foot and gives extra stability.

We'll show this in a lot more detail next month but here is the Ultimate Jukebox from the back, without back of course! At top is the notebook computer, centre is the actual speaker box and at the bottom, the electronics.

The handle

To help move the box, we wanted a pair of handles at the back so that it could be leant back onto the castors and rolled along. But when we priced handles at the hardware shop, we found they were about $4 each and worse, were puny (after all, they were intended for drawers). As we said earlier, the jukebox has significant weight and we were worried about the handles taking the load.

So instead of handles, we used bathroom towel rail and rail ends. It cost less than two handles and is a lot stronger. And if you're all sweaty after moving the Ultimate Jukebox around, you can always hang your wet towel over the rail . . .

We positioned the rail/handle immediately under the air vent on the rear of the box. Don't use the little woodscrews that came with the rail ends; we substituted countersunk head 5mm bolts and nuts which really anchored the thing in place.

The box is finito!

Now you can fit the speakers, woofer mesh grille, crossover . . . and start the wiring. The grille comes with four bolts and nuts – we discarded these and used the bolts that hold the woofer in place to also hold the grille. A piece of plastic surround comes with the grille – cut appropriate

Parts List – Ultimate Jukebox

"Hardware"
1 2400 x 1200 x 18mm sheet craftwood (MDF) (or 2 1200 x 1200 x 18mm)
1 450 x 900 x 32mm sheet craftwood (MDF) (base and notebook spacer)
2 435 x 350 x 2mm aluminium sheets
2m speaker carpet (1.8m wide)
1 380mm length 20mm diameter chromed towel rail
2 20mm towel rail ends
2 40mm swivel castors
1 380mm length 80 x 50mm timber (for front stand, carpet covered)
4 speaker corner protectors
50 50mm TEK woodscrews
8 40-50mm x 4mm (3/16") csk head bolts with nuts (for speaker and grille)
8 20mm x 8g woodscrews (for horn mounting)
4 30mm x 4mm csk head bolts with nuts (for handle mounting)
8 10mm spacers, tapped 3mm,
62 5mm x 3mm screws and nuts
4 10mm x 3mm screws and nuts
2 20mm x 3mm screws and nuts (for terminal block mounting)
3 solder lugs
2 3mm shakeproof washers (for common earth point)
2 fibre washers (for PreCHAMP PC board mounting insulation)
Around 2 litres contact adhesive (for speaker carpet)
PVA wood glue (for box assembly)

Speaker Section
1 high sensitivity, high power 300mm woofer [Altronics C3212]
1 compression horn driver [Altronics C6110]
1 horn flare to suit driver [Altronics C6130]
1 2-way 150W crossover [Altronics C4007]
1 300mm metal grille [Altronics C3712, Jaycar AX-3524]
1m medium-heavy duty figure-8 cable
1 8Ω 10W wirewound resistor (if required to attenuate tweeter)

Amplifier/Electronics Section
1 SC480 50W RMS amplifier module
[Altronics K5120, Jaycar KC-5345, DSE K3431]
1 power supply to suit [Altronics K5122, Jaycar KC-5347, DSE K3432]
1 28-0-28VAC Toroidal transformer to suit
[Altronics KM5120, Jaycar MM1095, DSE M-0144]
1 PreCHAMP Preamplifier (with modifications – see text)
[Altronics K2112, Jaycar KC5166, DSE K5608]
1 120kΩ 1/2W resistor (for PreCHAMP mods)
1 560Ω 1/2W resistor (for PreCHAMP mods)
1 3.5mm stereo plug
2 5.6kΩ 1/8W resistors
1 IEC mains input socket with integral fuseholder
[Altronics P8324, Jaycar PP4004]
1 IEC mains lead
1 mains-rated SPST rocker switch with neon
1 10kΩ log potentiometer
1 4-way mains terminal block
1 50 x 50mm piece blank PC board (or used copper-side down)
Scraps of aluminium for power supply and hard disk clamps, mains connections safety cover, etc.
1.5m length shielded cable, various lengths mains-rated connection cables, heat-shrink tubing, cable clamps, cable ties

Computer section
1 Notebook computer with mains power supply (Pentium 100 or better) running "Ultimate Jukebox" and "Winamp" software
1 External USB hard disk drive, if required due to inadequate hard disk space in computer
1 USB extension cable (if needed)
1 Trackball (or optical mouse), preferably USB

notches out of its back so that it clears the mounting bolts. Because it's very flexible, you can simply lift the front out of the way while tightening the mounting bolts.

The woofer mounts inside the box while the compression horn for the tweeter mounts in the rebate from outside the box. You can use either wood screws or nuts and bolts to hold the horn in position.

Wiring from the crossover to the speakers is self-explanatory – the crossover is clearly marked woofer and tweeter.

The figure-8 wiring from the crossover to the amplifier needs to go through one of two holes drilled in the bottom of the speaker box. Only drill a hole as large as you need to get this wire and the audio input wire (from the notebook) through. Later, you'll need to re-seal this hole with silicone sealant.

One point you will note from our photos is the 10W resistor in series with the tweeter. We included this because we thought the system sounded just a little "bright" – ie, too much treble. This is purely a matter of choice – you can include this if you wish (we used an 8Ω resistor) or not. If you want to experiment with the sound, anything from zero to say 20Ω would seem appropriate.

Obviously, a hole needs to be drilled through the top of the box to allow the audio input cable through. Choose a place where it doesn't interfere with the computer or its 32mm timber surround (we made the timber surround slightly undersize to achieve this.

A second pair of holes need to be drilled in both the enclosure top and bottom to allow the computer power cable and the USB cable between computer and hard disk to pass through. The USB plug will determine how big this hole needs to be.

Again, once the project is basically completed, these holes will need to be sealed. You might need a small piece of timber glued over the hole as well as silicone sealant to ensure the hole is plugged!

Oh no! We're out of room!

We had hoped to complete the Ultimate Jukebox this month but space has once again beaten us.

So next month we will cover the electronics assembly, testing and finally, blasting the neighbours. . . SC

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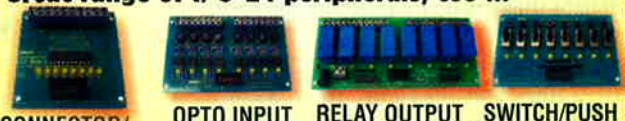

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PART 3 – BUILDING THE SENSORS AND STAND

BY JOHN CLARKE

As mentioned last month, there are two basic pad sensor types: those based around a piezo transducer and those based around the optical sensing circuitry. Which one you use is up to you.

The piezo-based pads require tapping with drum sticks or similar items in the conventional "drum" manner. The optical pads can be tapped by hand, making them easier to use.

We also use an optical pickup for foot-activated sensors. This is because the system is more robust. A piezo transducer that can be attacked with a foot pedal may well be destroyed rather quickly.

Each pad type is described in the separate sections following.

Building The Optical PC Board

Circuit details were shown in Part 1 but are repeated here for convenience along with the PC board overlay for the optical sensor (there is no PC board for the piezo sensor).

The optical sensor PC board is coded 01211053 and measures 52 x 31mm. Once again, before assembly check the underside for any possible shorts between tracks or breaks in the copper.

As you did for the other boards, install the resistors and diode (as shown), the PC stakes and the capacitor (which is mounted on its side to allow clearance above the PC board). Finally, the optical sensor is mounted directly onto the PC board, making sure it is oriented correctly.

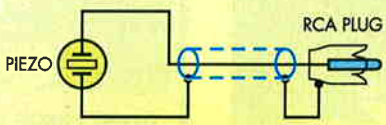


Fig.5: PIEZO SENSOR

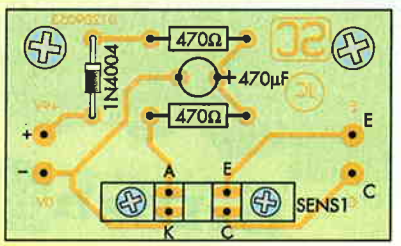


Fig. 7: OPTICAL PAD PC BOARD OVERLAY

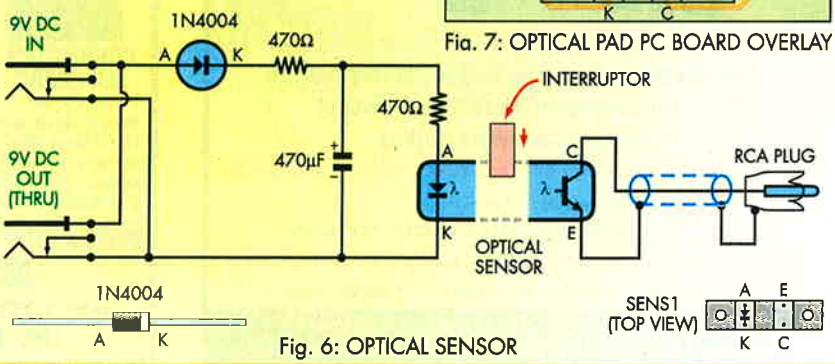


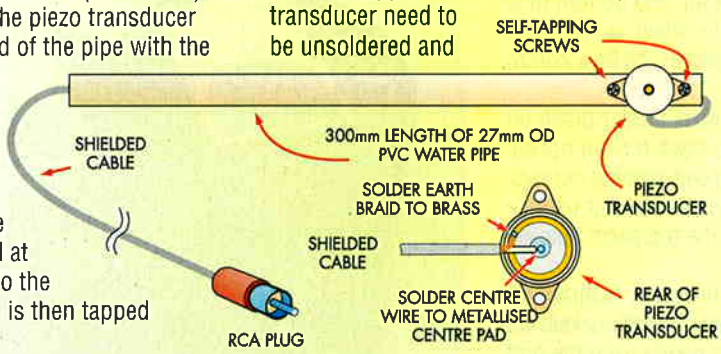
Fig. 6: OPTICAL SENSOR

The Simplest Piezo Sensor

The simple piezo sensor is based around a length of 20mm (27mm OD) PVC water pipe. The piezo transducer attaches to the end of the pipe with the shielded cable connected to the transducer and the other end to an RCA plug.

To use, the pipe is held in the hand at the opposite end to the piezo and the pipe is then tapped with a stick.

Note that the two red and black wires that are supplied connected to the piezo transducer need to be unsoldered and replaced with the shielded wire. You must carefully prise off the back of the piezo case to gain access to the wiring.



Parts List – Piezo Sensor

1 piezo transducer
1 300mm length of 20mm PVC water pipe (27mm OD)
1 2m length of single- cored shielded cable
1 RCA line plug
2 No.4 self-tapping screws

Percussive (Piezo) Sensor Pad

This sensor pad needs to be mounted onto a frame using 25mm tubing (see separate diagram). The sensor is played with a drumstick or similar item. Note that the front edge is shown curved to ensure that there is a consistent response from the sensor when the pad is tapped around its circumference.

Do not be tempted to use a rectangular edge. This will give dead spots in several positions on the pad where the sensor will not detect a strike on the plate. In addition, do not use metal in preference to the MDF since this will resonate for too long after it is struck.

The sensor pad is constructed as shown at right. Cut out the circular section of the MDF panel with a jigsaw and paint the pad with gloss black paint. The piezo transducer needs to be rewired to have the shielded cable soldered to its piezo and brass sections. The rear of the piezo housing can be carefully prised off to gain access to this wiring.

We used an epoxy resin smeared around the edge of the back of the piezo housing before securing with the M2.5 screws into the MDF. This ensures a good physical contact with the MDF plate.

The top of the MDF sensor plate can be painted black or covered with a thin sheet of vinyl using contact adhesive. The vinyl can deaden the sound produced by striking it with a stick.

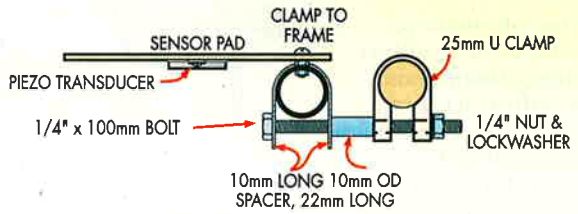
Alternatively, the stick can be rubberised. In most cases, the sound of the stick directly onto the painted MDF will not cause any concern.

Parts List – Piezo Pad

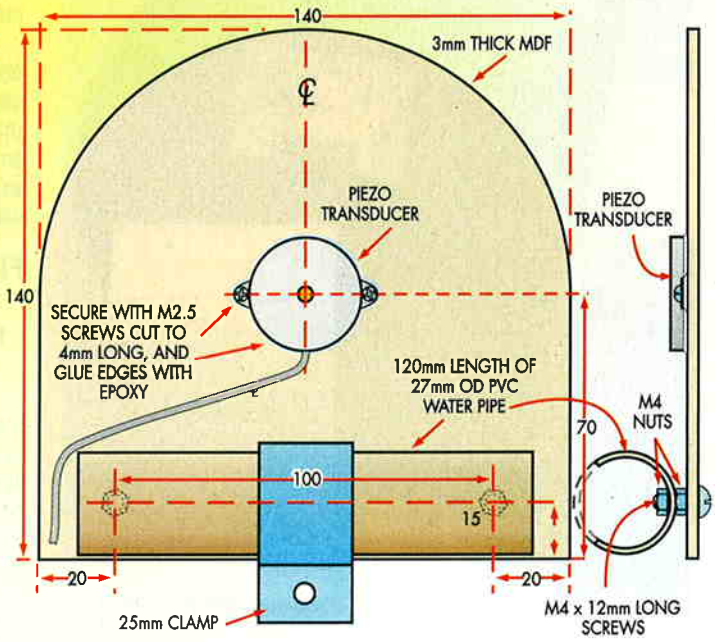
1 piezo transducer
1 140 x 140mm piece of 3mm MDF
1 120mm length of 20mm PVC water pipe (27mm OD)
2 25mm cable cleats (Farnell NP10 pro-power Cat 725-7399)
2 M4 x 12mm screws
4 M4 nuts
1 ¼" x 4" bolt and nut
1 6.35mm ID x 9mm OD x 22mm long plastic spacer (electrical lamp fitting)
2 M2.5 x 4mm long screws

Miscellaneous
Gloss black paint, vinyl (optional), epoxy resin, contact adhesive

This upside-down view of a piezo sensor pad is mainly to show the method of mounting the transducer. It also shows the method of mounting to the stand via a clamp and length of PVC pipe (also see diagram below).



DETAILS OF MOUNTING TO FRAME (~25% SCALE)



Bongo Drums

The bongo drums are made using 12mm MDF and 18g (1mm) aluminium sheeting. The MDF makes up the top and bottom dual semi-circular sections while the aluminium sheet is wrapped around the sides of the MDF and secured in place with 6g x 20mm countersunk wood screws.

Cutouts in the top are blocked off using MDF timber glued on the underside. These provide the mounting base for the optical sensor PC board to be secured using the 4g self-tapping screws. The MDF cut-outs and the semicircular shape can be cut using a jig saw. Glue the timber to the underside of the top panel cutouts and paint the timber.

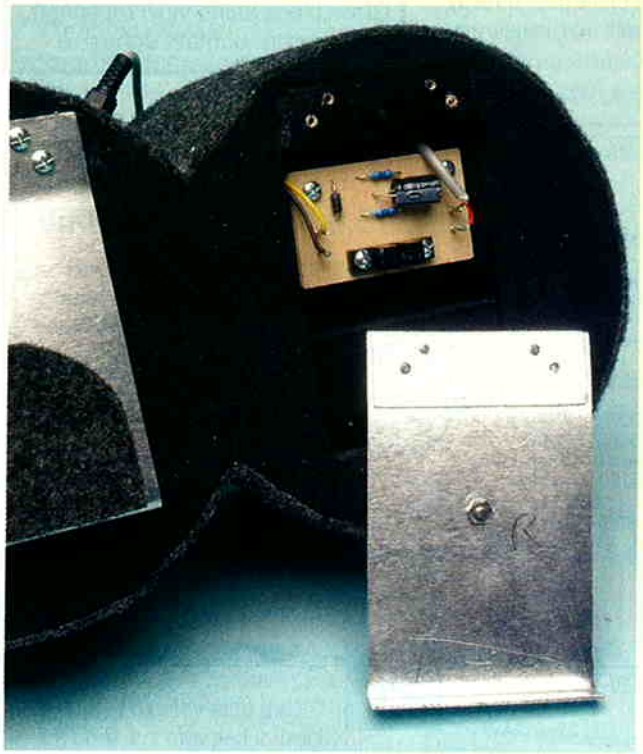
Wiring the PC boards involves following the overlay diagram for the optical pad sensor and wiring. Note that only two DC sockets are necessary – the second PC board derives its power from the first using hookup wire between the + and + power terminals and the - and - terminals. The DC sockets mount on the aluminium sides of the drums. The signal leads pass through the aluminium via a rubber grommet. A cable tie holding the two signal leads behind the grommet will help prevent the leads pulling out. An alternative arrangement is to attach two RCA panel sockets to the drum and use RCA-to-RCA leads for the signal connections.

Make up a DC socket to DC socket lead and terminate the signal leads with- RCA plugs.

The pressure plate is secured to the top of the drum using 4g screws. The screw that passes through into the optical sensor must be exactly located so that it fits neatly into the optical slot. The plate is bent as shown.

Adjustment

The slight upward bend allows the screw to have clearance inside the optical slot. This screw needs to be adjusted carefully so that there is a change in voltage at the signal output when the plate is moved.



The completed bongo drums. In the photo below left the drums are partially disassembled, showing the optical sensors and plates.

The easiest way to adjust this is to firstly make up an RCA socket to RCA plug test connector as shown below and insert this in line between the signal output lead and the MIDI Drum Kit. Alternatively, access the rear of the RCA socket inside the MIDI Drum Kit. Plug into one of the RCA input sockets for the MIDI Drum Kit.

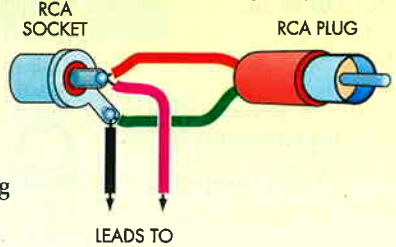
Apply power to the drum kit and also connect the DC power lead between the drum kit's DC output socket and one of the DC input sockets on the bongo drums. Connect a multimeter set to read DC volts to the test connector. The voltage reading should be either small (< 0.1V) if the screw is too far out of the sensor gap or up to 5V is the screw is too far into the slot.

Adjust the plate angle and screw setting so that the normal voltage is very close to 200mV. This voltage should rise to close to 5V when the plate is pressed. Ensure the plate is free to move without scraping the sides of the MDF and without the screw scraping the inside of the optical sensor.

With the arrangement shown having a nut on top and on the bottom of the plate, the screw can be turned in or out to make the adjustment. An alternative method is to cut the screw to length so that it does not need adjusting. If you have cut too much from the screw, the length can be built up with some solder. This makes it easy to file down so that the length is just right when the plate is secured down with the screws into the MDF panel.

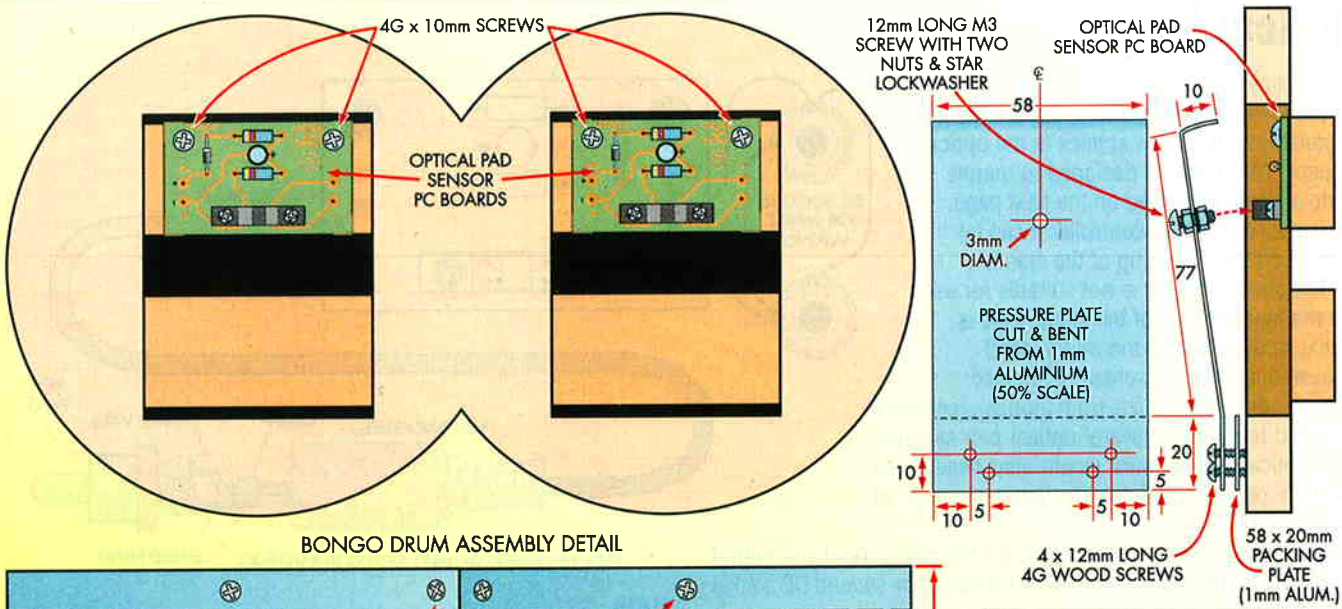
Finishing

We finished the drums by covering with loudspeaker carpet. This is attached with contact adhesive. The covering is optional.

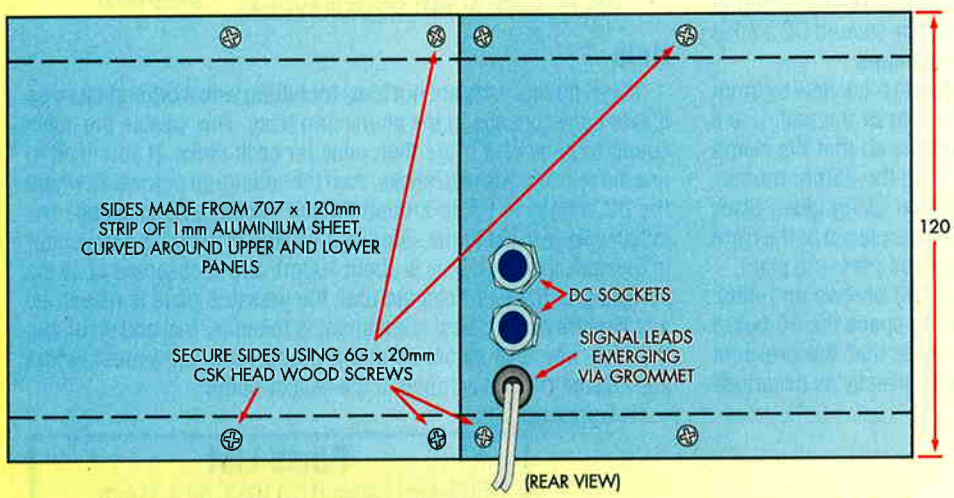


OPTIONAL SENSOR TEST JIG

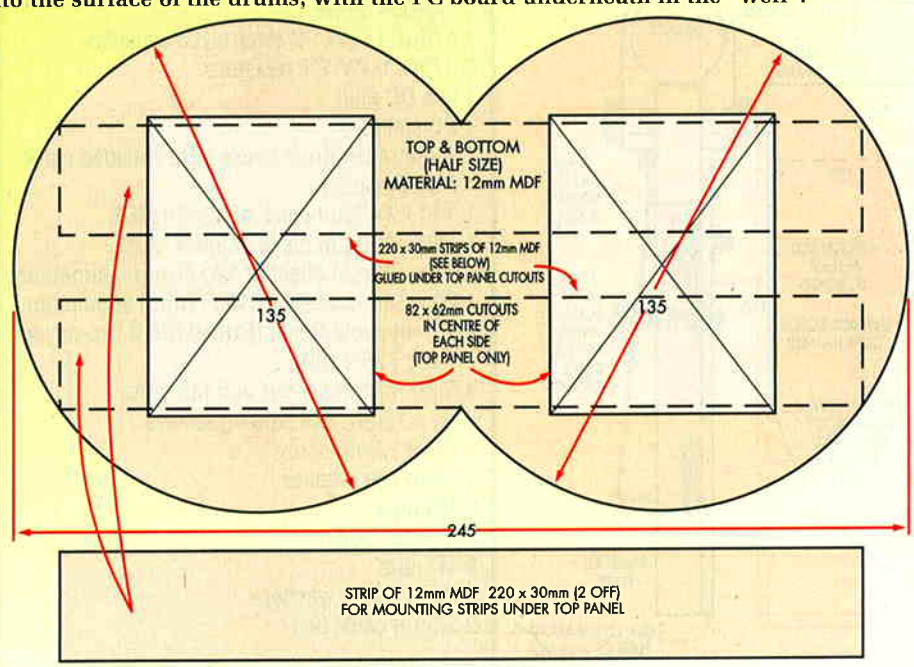
This easy-to-make jig will allow you to adjust the Bongo Drums (and other optical sensors) very easily, by connecting to your multimeter and adjusting the screw to give maximum voltage change.



BONGO DRUM ASSEMBLY DETAIL


SIDES MADE FROM 707 x 120mm STRIP OF 1mm ALUMINIUM SHEET, CURVED AROUND UPPER AND LOWER PANELS
120
DC SOCKETS
SIGNAL LEADS EMERGING VIA GROMMET
SECURE SIDES USING 6G x 20mm CSK HEAD WOOD SCREWS
(REAR VIEW)

Plan and elevation of the bongo drums. Top right shows how the pressure plate fixes onto the surface of the drums, with the PC board underneath in the "well".


TOP & BOTTOM (HALF SIZE) MATERIAL: 12mm MDF
220 x 30mm STRIPS OF 12mm MDF (SEE BELOW) GLUED UNDER TOP PANEL CUTOUTS
82 x 62mm CUTOUTS IN CENTRE OF EACH SIDE (TOP PANEL ONLY)
135
135
245
STRIP OF 12mm MDF 220 x 30mm (2 OFF) FOR MOUNTING STRIPS UNDER TOP PANEL

Speaking of the well, here's how to make it. This diagram is half the size of the finished drum – so if you have an enlarging photocopier, 200% is the magic number!

Parts List – Bongo Drums

2 PC boards coded 01211053, 52 x 31mm
2 Photo interrupters
2 1N4004 diodes
2 470µF 16V PC electrolytic capacitors
4 470Ω 1/4W 1% resistors
2 panel-mount DC sockets
2 line DC plugs
8 PC stakes
1 50mm long cable tie
4 metres single core shielded cable
2 RCA line plugs
2 135 x 245mm pieces of 12mm MDF
2 30 x 220mm pieces of 12mm MDF
2 120 x 707mm sheets of 18g (1mm) aluminium
2 61 x 108mm sheets of 18g (1mm) aluminium
2 20 x 58mm sheets of 18g (1mm) aluminium
8 4g x 12mm self-tapping screws
12 6g x 20mm csk wood screws
1 M3 x 12mm screw
1 3mm star washer
2 M3 nuts
1 6mm ID rubber grommet

Miscellaneous

Black paint, contact adhesive, speaker carpet (optional), PVA glue

Optical Sensor

In many ways, the optical sensor is similar to the Bongo drums in construction. Most of e construction for this applies to the optical sensor. The sensor is designed to mount onto a frame described on the next page. When used as a foot controller it can be placed on the floor rung of the stand.

The current design is not suitable for use on the higher rungs of the stand. This is because there will be too much stand movement when the sensor is pressed. A heavy-duty stand made from tubular steel could be used to support several optical pad sensors. The optical pad sensors would also need to be held in position with steel clamps instead of plastic ones.

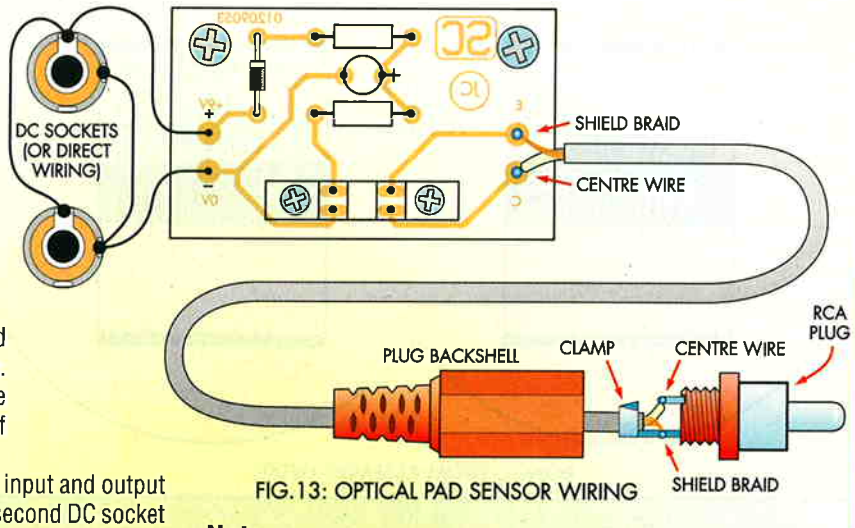


FIG.13: OPTICAL PAD SENSOR WIRING

In addition, use two DC sockets for the power input and output as shown in the main optical sensor wiring. The second DC socket allows for interconnecting power between sensors.

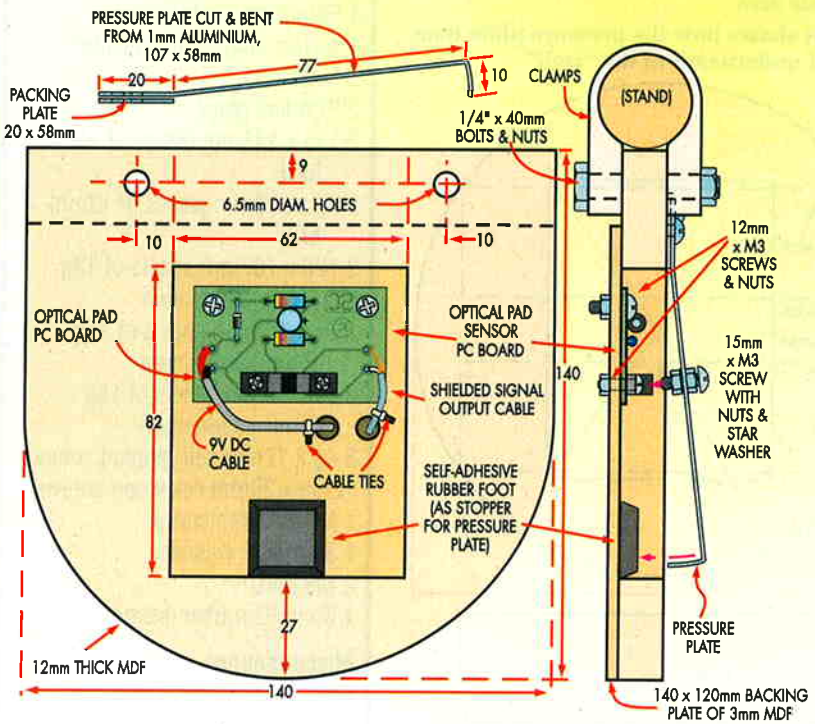
The 12mm MDF will require trimming back in thickness by 3mm where the two plastic clamps attach at the rear of the pad. Use a chisel to do this. The reduction in thickness is so that the clamp will close up sufficiently to mount tightly onto the 25mm frame.

The MDF material for the sensor is painted using gloss black paint before assembly. A rubber stick-on foot is placed at the front edge of the cut-out to provide a stopper for the pressure plate.

The sensor PC board is attached using M3 screws and nuts. You may need to use some Nylon washers to space the PC board slightly above the 3mm MDF baseplate. Note that the pressure plate needs the centre screw to be adjusted correctly as described in the bongo drum section.

Note

These optical pads are not ideal for hitting with a drumstick since it sets up resonance in the aluminium plate. This causes the drum sound to be played more than once for each strike. If you need to use the optical pads with sticks, then the setting-up procedure where the DC voltage is set to around 200mV needs to be changed. The initial voltage is set to the saturation voltage of the output transistor in the optical sensor. This is about 100mV and is observed to be the voltage that does not change until the pressure plate is moved by a millimetre or two. Best adjustment is found by trial and error, but the plate needs to be set so that it needs some movement before any voltage change is found at the sensor output.



Again reproduced half size, this diagram shows how the optical sensor unit is constructed.

Parts List

1 PC board coded 01211053, 52 x 31mm
1 Photo interrupter
1 1N4004 diode
1 470µF 16VW PC electrolytic capacitor
2 470Ω 1/4W 1% resistors
1 line DC plug
4 PC stakes
1 2-metre length of single core shielded cable
1 RCA line plug
1 140 x 142mm piece of 12mm MDF
1 140 x 120mm piece of 3mm MDF
1 61 x 108mm sheet of 18g (1mm) aluminium
1 20 x 58mm sheet of 18g (1mm) aluminium
2 25mm cable cleats (Farnell NP10 pro-power Cat 725-7399)
4 M3 x 12mm screws and M3 nuts
4 4g x 12mm self tapping screws
1 M3 x 12mm screw
1 3mm star washer
2 M3 nuts
2 4" x ¼" bolts
2 ¼" nuts
4 3mm Nylon washers
2 50mm cable ties

Miscellaneous
Black paint, PVA glue

Building A Playing Stand

One or two sensors alone are fine sitting on a bench, etc, (or even the floor!) but when a number of sensors are used, some form of frame or stand is necessary so they can mount in their correct positions for playing.

We made up a stand using conventional hardware components. Broomsticks were used instead of dowell because they're usually a lot cheaper!

The stand was glued together with builders' adhesive for the Tee joins and PVA glue for the MDF bracket to the 25mm rod. It was painted in a gloss black.

Note that the design allows the top rung to be removed. This is for easy transport of the frame on the back seat of a car.

The broomstick pieces are cut to length, noting that the stick is passed right through the T-piece rather than cutting it at this point. Each T-junction is made stronger by making a 25mm hole part way into the side of the straight through broomstick.

Note that the Vinidex T-pieces allow the broomstick to pass easily through it. Other brands may need drilling or filing out to allow the stick to enter right through the piece.

The MDF right angle bracket is included to give extra support in the forward and backward direction.

The wires for the sensors can be made tidy along the frame using cable clips.

The percussive sensor is designed to be able to be adjusted to any angle, making it very suited for stand mounting.

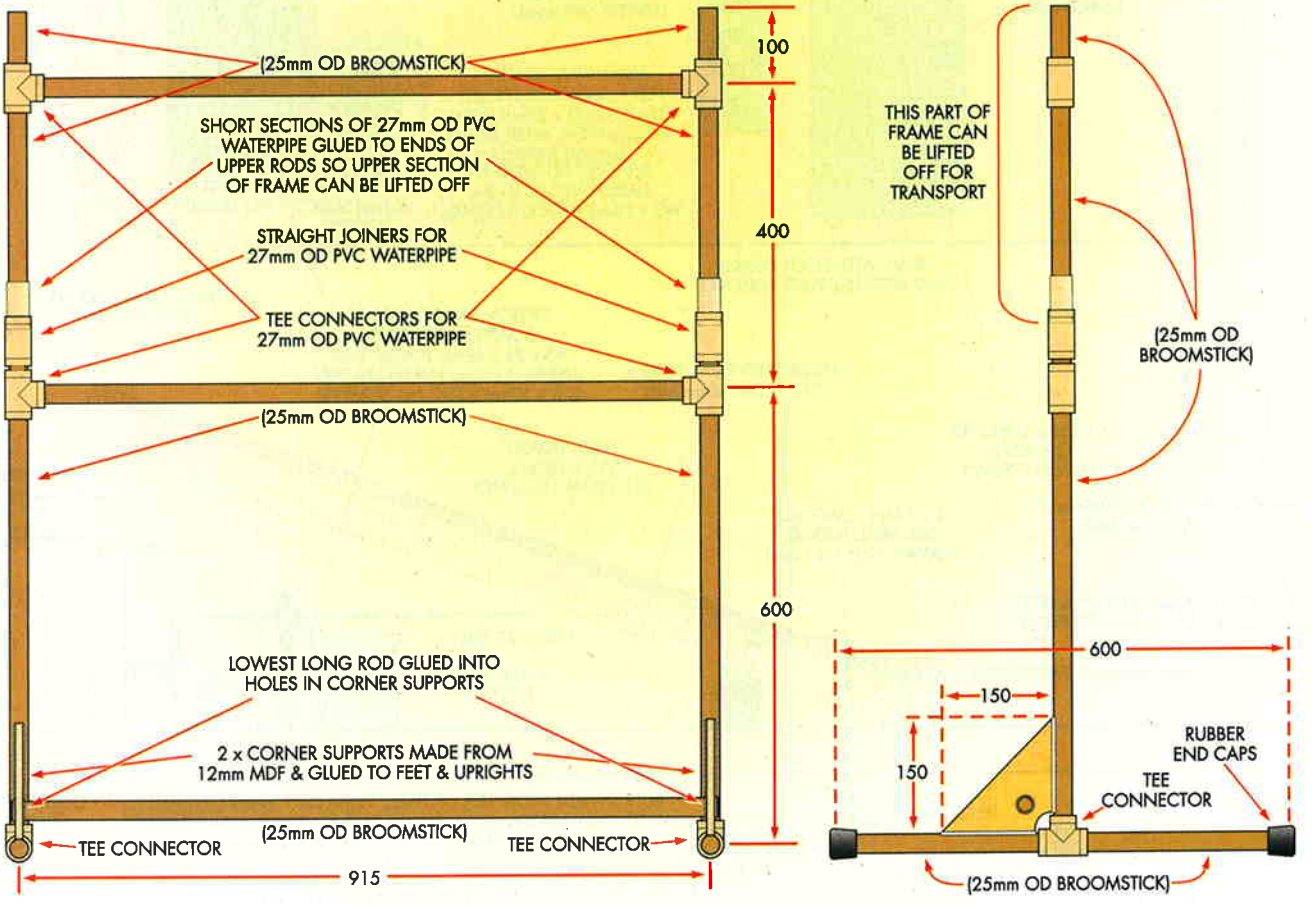
However, if using the optical sensor on the stand, it must be mounted on the floor rung of the frame, so the front edge of the pad rests on the floor to add extra support.

As mentioned, the stand and optical sensor pad mounting must be of heavier construction than the one shown here if you intend to use optical pad sensors throughout.

Parts List

6 broom sticks, 25mm in diameter
6 20mm PVC water pipe Tee pieces (Vinidex)
2 20mm PVC water pipe joiners
1 150 x 150mm x 12mm MDF sheet
4 25mm rubber pipe ends

Miscellaneous
Black gloss paint, PVA glue, builders adhesive


(25mm OD BROOMSTICK)
SHORT SECTIONS OF 27mm OD PVC WATERPIPE GLUED TO ENDS OF UPPER RODS SO UPPER SECTION OF FRAME CAN BE LIFTED OFF
STRAIGHT JOINERS FOR 27mm OD PVC WATERPIPE
TEE CONNECTORS FOR 27mm OD PVC WATERPIPE
(25mm OD BROOMSTICK)
LOWEST LONG ROD GLUED INTO HOLES IN CORNER SUPPORTS
2 x CORNER SUPPORTS MADE FROM 12mm MDF & GLUED TO FEET & UPRIGHTS
TEE CONNECTOR
(25mm OD BROOMSTICK)
TEE CONNECTOR
915
100
400
600
THIS PART OF FRAME CAN BE LIFTED OFF FOR TRANSPORT
(25mm OD BROOMSTICK)
600
150
150
RUBBER END CAPS
TEE CONNECTOR
(25mm OD BROOMSTICK)

STAND CONSTRUCTION (10% SCALE)

This is the stand we put together from bedknobs and broomsticks (OK, not too many bedknobs). It's just one possible arrangement for mounting the controller and various sensors, giving room for foot pedals underneath.

Foot Controller

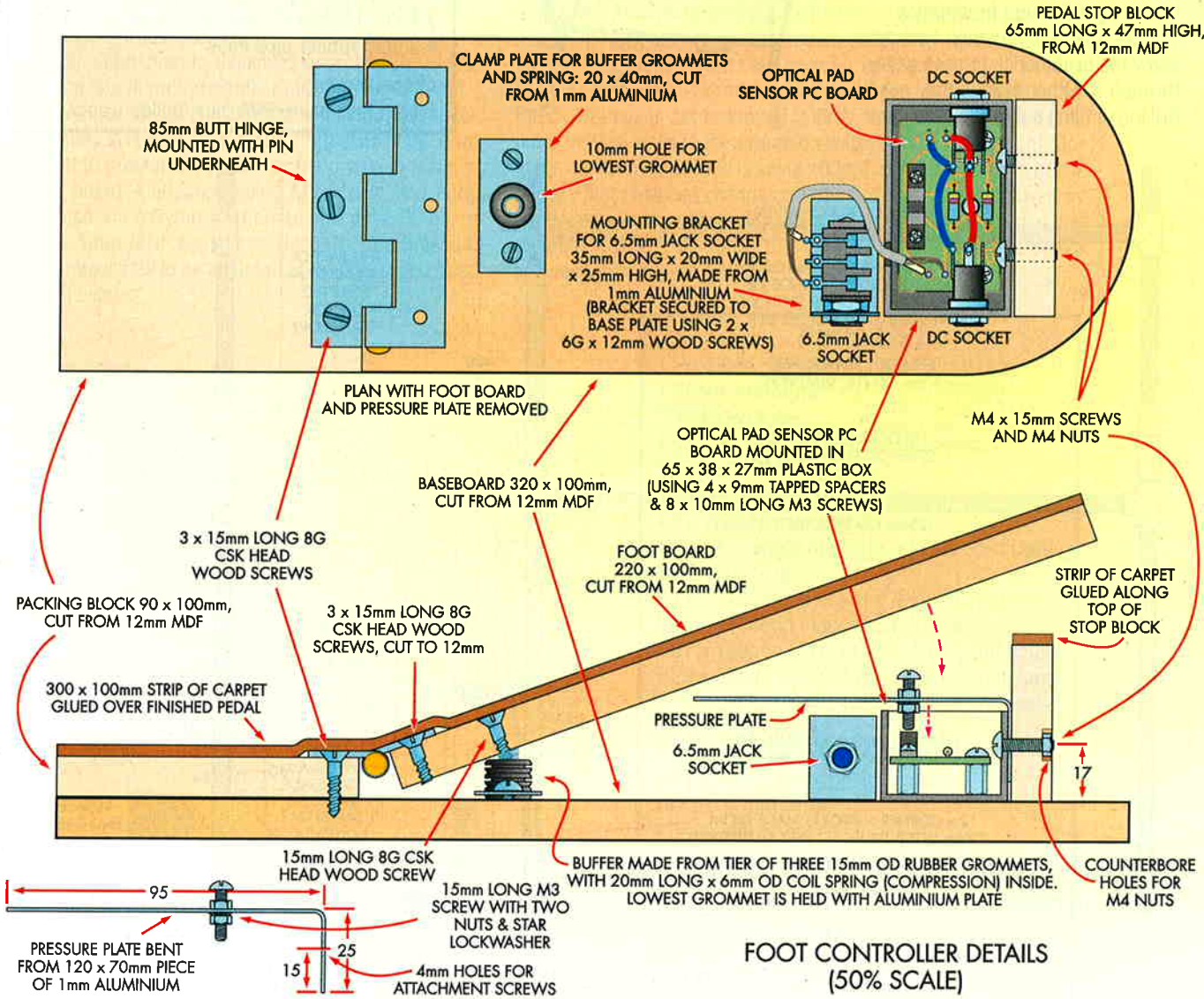
The foot controller is generally used to control a bass drum sound. We show how to build a foot controller for this purpose using an optical sensor. An alternative foot controller is shown under the Optical pad heading.

The optical pad is made into a plastic box and secured to the upright MDF piece with M4 screws and nuts. This also sandwiches the pressure plate in between the box and MDF. The PC board for the optical pickup is supported on M3 tapped standoffs (9mm long) and held using M3 x 10mm screws.

The screw mounted in the pressure plate to interrupt the optical sensor must be adjusted as described in the Bongo Drums set-up.

The DC sockets are mounted at each end of the box. The signal output is wired to the 6.35mm jack socket that is mounted on an aluminium bracket. You will need to make up a 6.35mm jack plug to RCA plug lead for the connection between the foot controller and the MIDI Drum Kit.

The footswitch is made using the MDF panelling as shown. We painted the assembly with black paint and covered the foot areas with speaker carpet.

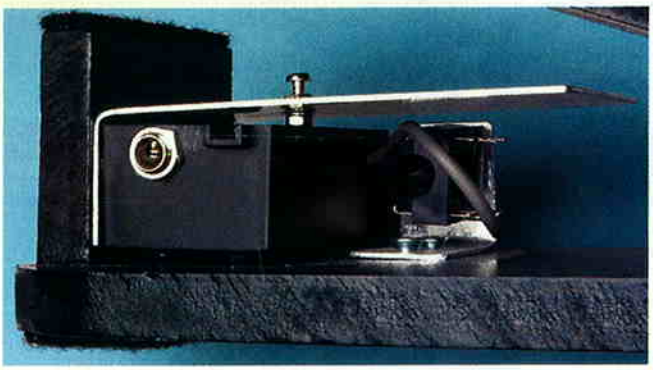

PEDAL STOP BLOCK 65mm LONG x 47mm HIGH, FROM 12mm MDF
CLAMP PLATE FOR BUFFER GROMMETS AND SPRING: 20 x 40mm, CUT FROM 1mm ALUMINIUM
OPTICAL PAD SENSOR PC BOARD
DC SOCKET
85mm BUTT HINGE, MOUNTED WITH PIN UNDERNEATH
10mm HOLE FOR LOWEST GROMMET
MOUNTING BRACKET FOR 6.5mm JACK SOCKET 35mm LONG x 20mm WIDE x 25mm HIGH, MADE FROM 1mm ALUMINIUM (BRACKET SECURED TO BASE PLATE USING 2 x 6G x 12mm WOOD SCREWS)
6.5mm JACK SOCKET
DC SOCKET
PLAN WITH FOOT BOARD AND PRESSURE PLATE REMOVED
M4 x 15mm SCREWS AND M4 NUTS
OPTICAL PAD SENSOR PC BOARD MOUNTED IN 65 x 38 x 27mm PLASTIC BOX (USING 4 x 9mm TAPPED SPACERS & 8 x 10mm LONG M3 SCREWS)
BASEBOARD 320 x 100mm, CUT FROM 12mm MDF
3 x 15mm LONG 8G CSK HEAD WOOD SCREWS
FOOT BOARD 220 x 100mm, CUT FROM 12mm MDF
STRIP OF CARPET GLUED ALONG TOP OF STOP BLOCK
PACKING BLOCK 90 x 100mm, CUT FROM 12mm MDF
3 x 15mm LONG 8G CSK HEAD WOOD SCREWS, CUT TO 12mm
300 x 100mm STRIP OF CARPET GLUED OVER FINISHED PEDAL
PRESSURE PLATE
6.5mm JACK SOCKET
17
15mm LONG 8G CSK HEAD WOOD SCREW
BUFFER MADE FROM TIER OF THREE 15mm OD RUBBER GROMMETS, WITH 20mm LONG x 6mm OD COIL SPRING (COMPRESSION) INSIDE. LOWEST GROMMET IS HELD WITH ALUMINIUM PLATE
COUNTERBORE HOLES FOR M4 NUTS
95
15mm LONG M3 SCREW WITH TWO NUTS & STAR LOCKWASHER
PRESSURE PLATE BENT FROM 120 x 70mm PIECE OF 1mm ALUMINIUM
25
15
4mm HOLES FOR ATTACHMENT SCREWS
FOOT CONTROLLER DETAILS (50% SCALE)

If you want to build your own foot controller, here is how to do it. The alternative is to use the information in this diagram to modify a commercial foot pedal.

Parts List

1 PC board coded 01211053, 52 x 31mm
1 bulkhead plastic box, 65 x 38 x 25mm
1 Photo interrupter
1 1N4004 diode
1 470µF 16VW PC electrolytic capacitor
2 470Ω 1/4W 1% resistors
1 6.35mm mono jack socket
2 line DC plugs
4 PC stakes
1 2-metre length of single core shielded cable
1 6.35mm mono plug
1 RCA line plug
1 65 x 120mm length of 1mm aluminium
1 20 x 40mm length of 1mm aluminium
1 60 x 20mm 1mm aluminium
1 100 x 35mm sheet of 1mm aluminium
1 85mm but hinge
6 8g csk wood screws cut to 12mm
7 6g csk wood screws cut to 12mm
1 5g x 20mm screw
1 M3 x 15mm screw
1 3mm star washer
2 M3 nuts
2 M4 x 15mm screws
2 M4 nuts
4 M3 tapped x 9mm spacers
8 M3 x 6 screws
1 20mm long by 6mm OD compression spring (from clothes peg)
3 15mm OD x 6mm ID rubber grommets
1 100 x 320mm length of 12mm MDF
1 100 x 80mm length of 12mm MDF
1 100 x 220mm length of 12mm MDF
1 65 x 47mm length of 12mm MDF

Miscellaneous
Black paint, PVA glue, speaker carpet, contact adhesive



Footswitch

The footswitch is a commercially made unit – all it really needs is to have an RCA plug wired to its end. However, the wiring supplied with the switch is a little too thick for the RCA plug so is best replaced with a single core shielded cable instead. Connect the wire between the normally open and common connections on the microswitch.

Parts List

1 footswitch (eg, Jaycar SP-0760)
1 1m length of single core shielded wire
1 RCA line plug

NEXT MONTH:
The final part – software – and how to drive it!

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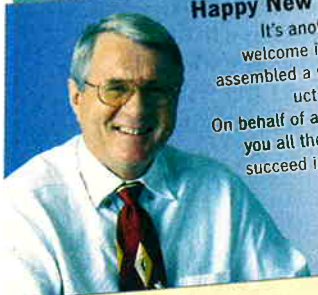

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Intense beam travels up to 50m!

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- AC/DC volts • Capacitance
- Resistance • Transistor/diode check

$40 Q 1132 RRP $49.95

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Great for motorhome, caravan and boat lighting. Also ideallly suited for feature & cabinet lighting around the home. For 12V DC power applications. 1W light output.

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X 2206 Warm White

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A truly professional power supply, will last a lifetime!

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Power up almost any appliance, gadget or toy! With adjustable voltage setting to suit most devices. Supplied with 6 interchangeable tips.

	RRP	NOW...
M 8980 0.8-1.6A max 3-12V	$33ea	$22
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Up to a whopping 1.6A in a slimline plugpack!

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Regulated precision for voltage critical devices

Compact switchmode design is both powerful and lightweight. Great for powering communications equipment, car audio amplifiers, camping fridges or other portable DC power appliances. 3 to 30V regulated output @ 20A max.

$300 M 8212 RRP $369

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Massive 57mm high digit. Common cathode, red illumination.

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Add 4 inputs to your AV system! Dual outputs are perfect for those wanting to switch a source to two televisions, or even a television & a wireless video sender. Features S-Video & Composite RCA connections. No power required.

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C 9004
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Great value for money! Featuring superior diaphragm drivers with samarium cobalt magnets! Supplied with 3.5mm stereo plug & 6.5mm adaptor.

SAVE OVER 30%!

Build your own speaker system!

...or refurbish those old favourites! Great for custom subwoofer cabinets for car, home theatre or hi-fi. Consult website for full specs. All 8Ω.

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C 3070 100W 12"	$89ea	$140

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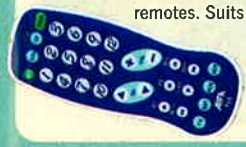

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A 1013
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NEW KIT!

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Power leds up to 5 watts!

$29.95
K 1010

(SC May '04) Powers up two 1W/3W LED's or a single 5W LED. The unique switching regulation employed means that it is very efficient and produces very little heat. Its 12V input makes it perfect for boats, cars & caravans, anywhere low voltage lighting might be required!

BONUS BUY: Buy the K 1010 kit & Z 0251 1W Star for just **$35! THAT'S A SAVING OF $8.90!** (K 1010S)

Don't get caught with a flat battery!

Ensures you have enough juice left in your battery to start your car. This ingenious kit is great for people with caravans, recreational vehicles etc. It simply cuts power to portable appliances (eg: camping fridge) whenever battery voltage drops to a preset level (between 10.9-11.9V).

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K 4328
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NEW!

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2 Way

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$9.95
K 3015
4 Way

Great idea to make kit construction easy!

Tiny 25W Amplifier Module

Hurry, stocks limited!

Great little test amplifier! Amazing price! Delivers 25W RMS into 4Ω. Can be powered from single or split voltage rails. Includes heatsink.

$16
K 5113
RRP $21.95

Compact 2 x 50W Amplifier Kit

Includes heatsinks & power supply components*

$59
K 5130
RRP $73

Great value!

Build yourself a superb sounding amplifier in under a day! This stereo module is a complete audio solution, producing 47W RMS into 8Ω with very low distortion. *Transformer to suit (M 5325) available separately.

Compact high spec 4 channel AV switcher kit

$50
K 5842
RRP $69.95

(SC June 01)

Why pay a fortune for a ready made surveillance switcher? This kit saves you $$$!

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433MHz + Picaxe = Magic!

You've no doubt heard of Murphy's, Ohm's and Moore's Laws . . . but how about Swan's Law – "You can never have too many thermometers"?

by Stan Swan*

Here's a Picaxe-controlled wireless version that should suit many needs and YES! – it's legal, as the only Australian/NZ 433.92MHz LIPD ISM regulatory restriction is that the transmitter should not exceed 25mW EIRP (Effective Isotropic Radiated Power).

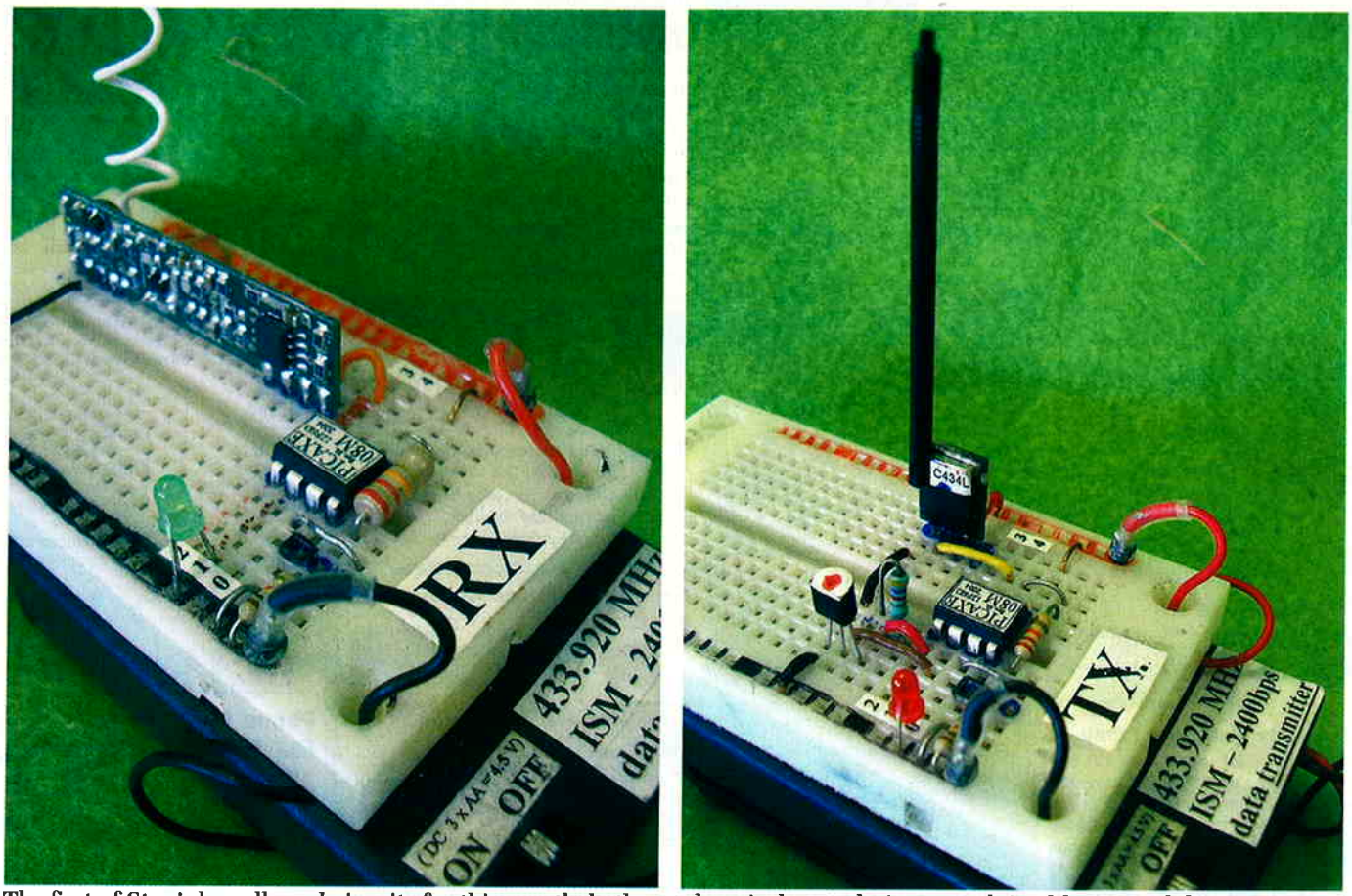
Since Picaxe-08M microcontrollers work so well with 433MHz UHF data modules (see last month), it's tempting to further link the pair to industry-standard DS18B20 Dallas Semiconductor (Maxim) digital temperature ICs and make a simple Picaxe-08M driven wireless thermometer.

Direct Celsius temperature data can be then transmitted some 50 metres and shown on a PC attached to the 433MHz receiver (with perhaps further treatment under Excel).

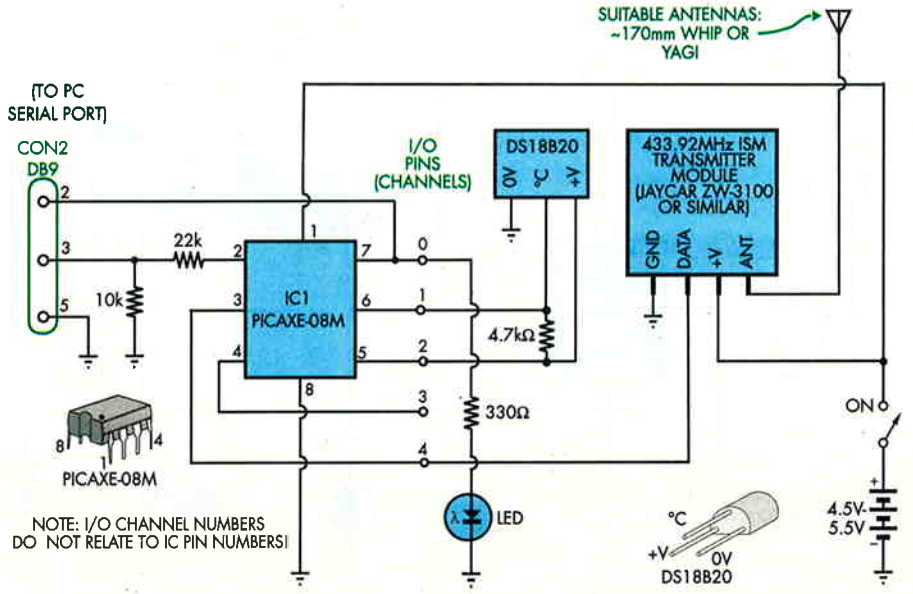
A simple antenna extends this range to more like 300m, while a Picaxe-controlled data repeater can even push ranges to perhaps 500m and may allow coverage when obstacles otherwise block weak signals.

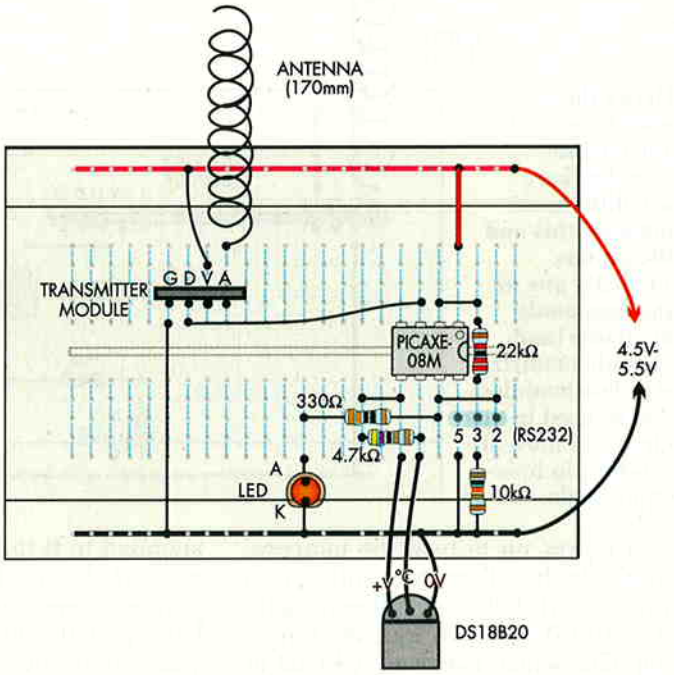
What's involved

As initially mentioned in the December 2005 SILICON CHIP article, we've now migrated to the Mk.2 PICNIK box layout approach (see the



The first of Stan's breadboard circuits for this month: both use the wireless techniques explained last month but now they've taken on Picaxe control. Aaaaah – Stan's two loves in one circuit? He's in rapture . . .





Here's the Picaxe-controlled wireless thermometer – the circuit at top and the breadboard layout at right. There are subtle differences between this layout and the photo at left – neither is "wrong" but the one at right is a little easier to follow in printed form.

www.picaxe.orcon.net.nz/picnik2.gif "slide show"), which conveniently has room enough for a Picaxe-08M and the 434MHz Tx/Rx units. It's again strongly recommended that you first lay out the circuit on such solderless breadboards (as we've shown here), allowing things to be better understood and tweaked. The final soldered versions should be the last stage in your design– not the first!

However, for eager constructors "more confident in their abilities" and wanting to build just the final version, it's suggested that Dick Smith Prototype Board (DSE H-5605) be used. Its 0.1-inch-spaced solder pads are laid out exactly the same as the breadboards, allowing almost a "paint by number" approach to board stuffing. Rather than soldering the Picaxe and 433 units directly onto this board, use 8-pin IC sockets. The same can be said for the transmitter and receiver modules – cut the IC sockets in half lengthways.

The DS18B20 can of course be extended away from the board with three wires but ensure their solder joints are waterproofed with epoxy or neutral silicone sealant for measurements in damp areas. See a possible approach at www.picaxe.orcon.net.nz/pvdemo.jpg

The DS18B20 digital temperature IC is, confusingly, a look-alike to cheap BC547 transistors and mixups may arise unless it's boldly marked – here whiteout and a red felt tip dot has been used to avoid any possible circuit confusion.

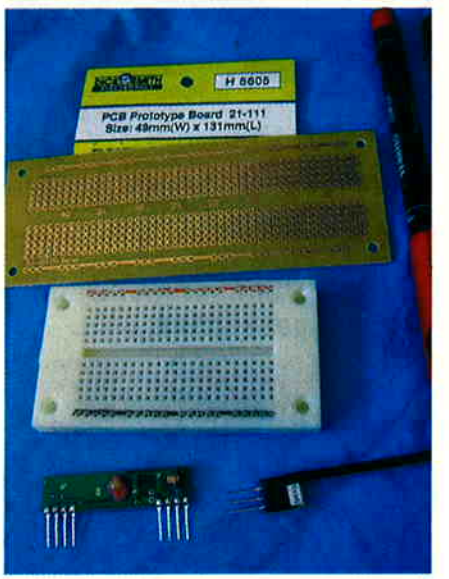
As outlined last month, the various LIPD modules are usually pin-for-pin compatible, so most of the common 433.92MHz transmitters can be used, although the antenna position may vary on some. One I found even had its antenna pre-wound and bonded to the module.

The receiver assembly may need more consideration, since the Jaycar version needs a nominal 5V supply and may be less tolerant of three 1.5V AAs (ie, 4.5V) for the supply unless the cells are fresh. Consider perhaps four NiCd/NiMHs (4 x 1.2 = 4.8V) instead, or even 4 x 1.5V cells (thus 6V) and a series silicon diode to drop that back to around 5.4V (as outlined later).

The Mk.2 PICNIK box has room for either a three or four AA-cell switched battery box anyway

Once the Tx and Rx boards are assembled and powered up, simply port over the correct code (www.picaxe.orcon.net.nz/434tx.bas and www.picaxe.orcon.net.nz/434rx.bas) from the Picaxe Editor PC to the matching setup.

Following the energy saving SLEEP command (initially set to about one minute – modify to suit), the DS18B20



The alternative construction methods: our familiar breadboard and above it, a DSE Prototype Board. It's easy to transfer circuits from one to another because both use the grid system.

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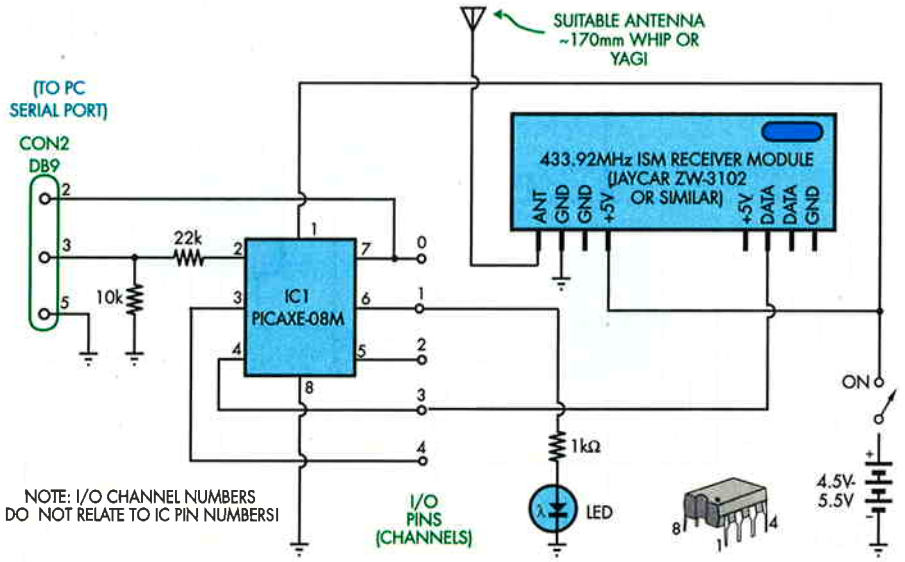
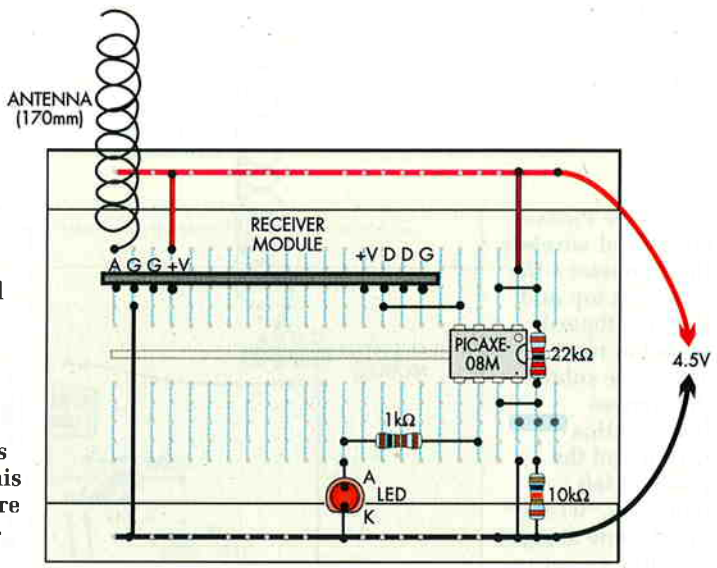




Here's the matching receiver module – again, there are differences between this and the photos. Virtually any of the commonly available (and cheap!) 433MHz wireless modules can be used in this circuit as most are pin-for-pin interchangeable.

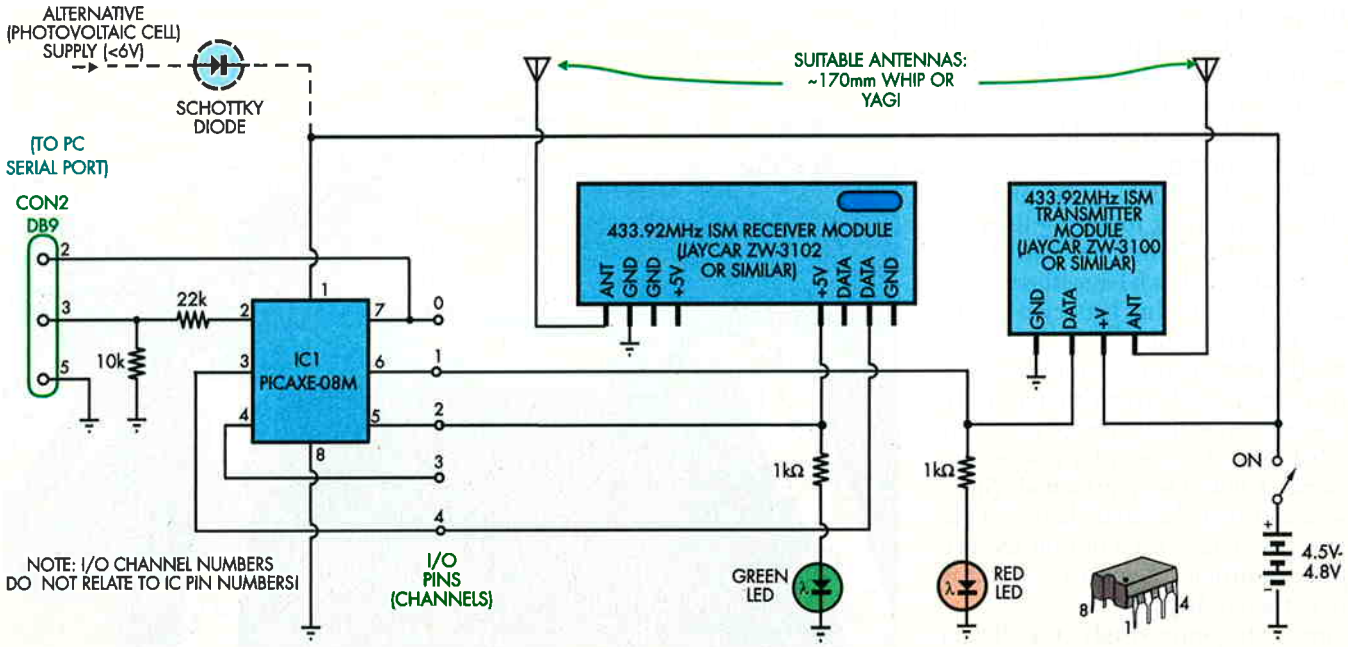
will power up to read the temperature, which is then transmitted as a variable (b1) before shut down again. A red LED winks to indicate outgoing data, which has been reduced in speed to just 300 bps for reliability. There's little point in sending faster when the unit will spend considerable time idling between readings and the Picaxes could even be under-clocked to further slow data rates if superior reception is needed – this may also prolong battery life.

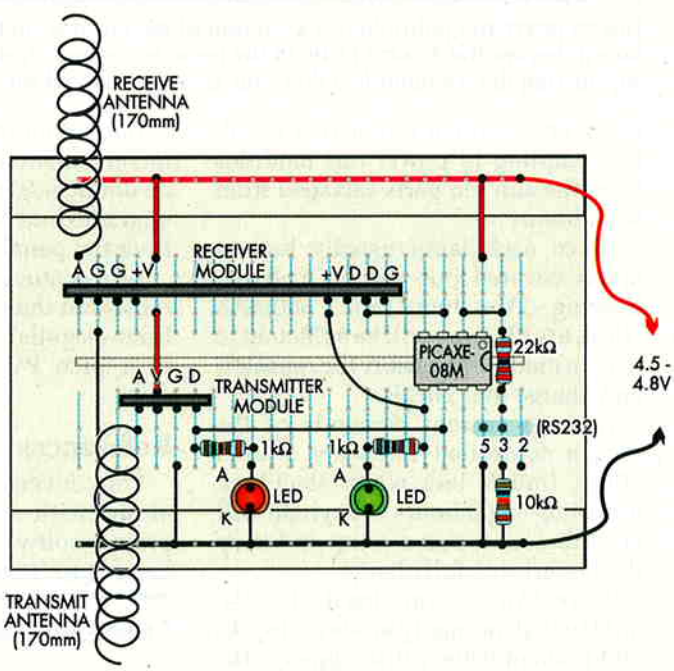
At the receiver (if in range) the unit first has to be given a preamble to ensure it's listening carefully – experimentation showed that a good burst of ASCII 85s ("U" being 01010101) ensured it was suitably responsive.

A further "ABC" qualifier is then added to the transmitted serial string, with a similar sequence at the receiver, to ensure that data will only be responded to if this preceding ABC is present. Naturally, with numerous wireless garage door openers, door bells and the like now abounding, you don't want false triggering every time the place next door has visitors – or vice versa.

There's a parallel here with WW2 coded BBC messages of course – only if a pre-determined phrase such "My hovercraft is full of eels" was broadcast would the listening partisan group blow up the rail bridge, etc. Being 2006 rather than 1945, instead of bridges the alerted SERIN command takes the b1 temperature variable and directs it via the Picaxe programming cable to the PC for editor "F8" 4800bps terminal window display.

Other readouts, perhaps an LCD module or old organiser suitably driven by SEROUT, could easily be used instead.





Put a receiver and transmitter module together and what do you get? A repeater, of course! The code for the Picaxe control can be found on Stan's website (address at end of this article).

With the use of the Picaxe WRITE and READ commands, quite a stack of these variables could be stashed in EEPROM for later retrieval as well of course, effectively making a wireless temperature data logger.

Every school should make one to explore and experiment !

A simple quarter-wave antenna (~165mm at 433-4MHz), perhaps spiraled somewhat for compactness, should give a range through wooden walls of about 50m.

For coverage beyond this, consider antennas such as the Yagi "cotanga" or magnetic pickup version described last month (**www.picaxe.orcon.net.nz/yagi433.jpg**) and if used at both ends perhaps 300m range may result.

In situations where the transmitter signal is well shielded from the receiver behind metalwork, buildings, hills or extensive vegetation you'll need a bit more ingenuity.

A repeater!

Taraaaa! You saw it here first – a dead simple but effective Picaxe controlled 433MHz data repeater.

The Picaxe driving code is a breeze, but keep in mind it's only set up to "store and forward " a single variable, so don't expect WiFi bandwidth!

Since the baby 08M has spare I/O channels and memory, it was tempting (and indeed proved feasible) to use its idle capacity to "store and forward" the temperature data.

The technique is akin to LEO (Low Earth Orbital) "flying mailbox" satellites which take in weak ground signals, when over a remote area, for resending as they pass over a base station perhaps 20 minutes later.

When placed in an elevated RF sweet spot (and perhaps solar-powered), enhanced signal broadcasting results, allowing data gathering from areas that may otherwise be UHF black holes – a cave or well perhaps.

The small 230 hole (+ 40 supply

And here's the breadboard layout of the repeater. The long black object is also an antenna – just a different type than our curly wire version.

rail) breadboards we used nicely fit both a 433 Rx and Tx module alongside the Picaxe, and following simple hookup wiring the repeater can be programmed with **www.picaxe.orcon.net.nz/434rpt.bas**.

To show its action, green and red LEDs (for awaiting receiving then retransmitting) connect via 1kΩ dropping resistors – much larger than really needed but reducing battery drain to just a few milliamps.

433MHz transmitters only come on when data is fed to them but naturally the sensitive receiver must be switched off before the transmitter comes on, otherwise it will be overloaded. Such needs can again be easily handled via our Picaxe, since each output has the ability to provide ("source") ~ 20mA current when high.

Somewhat annoyingly, the Picaxe SERIN command can't be interrupted or timed out but completely stops processing until a suitable signal arrives, meaning the receiver can only be switched off (and the program able to continue) after such prescribed data is received.

There's a parallel here with fishing and the discard of any less worthy catches, as you'll only go home when a desirable barramundi (?) is in the bag.

Note: the temperature data handling here is a simplex in nature, and similar to a radio station sending out programs. Extensive data massaging, using CRC error detection or even half duplex confirmation is rather beyond this initial article so has not been considered, although is mentioned in the references.

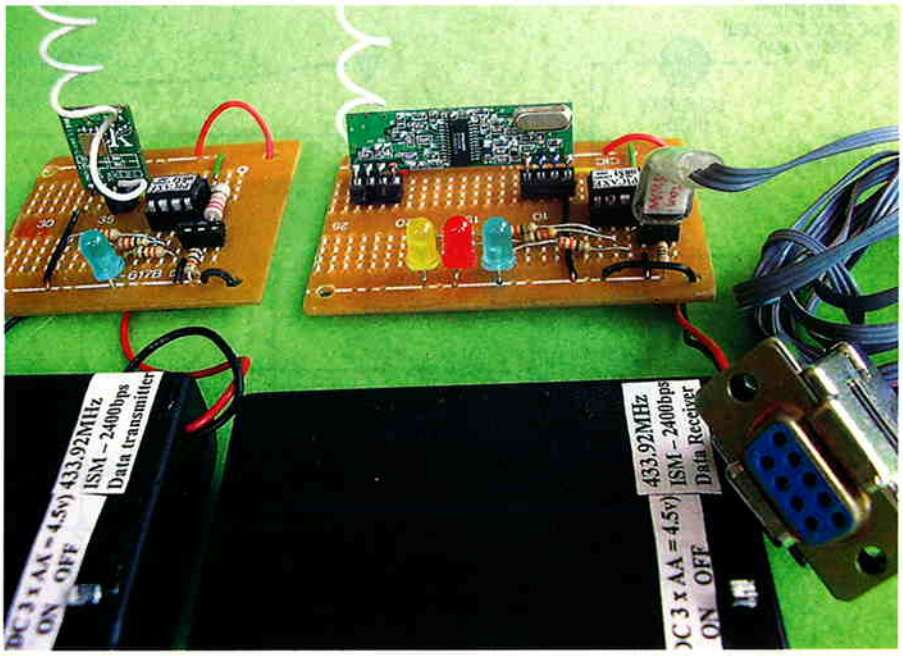
If the receiver is close to both the sender and the repeater, a double set of data will show up on the screen as the two signals are received.

Although you'll obviously not need the resending in such a strong signal arrangement, normally position the repeater where it can just reliably hear the sender and the receiver can further hear the repeater's outgoing signal.

Perhaps initially reduce the SLEEP to just a few seconds to speed up the process, as the informative switching LED patterns will greatly help positioning.

Solar power?

With hardware and gift/bargain stores now displaying racks of solar powered garden lamps at near throw-away prices (often under A$5 each), it's tempting to power our modules from the sun via parts salvaged from such lamps.



Just to prove the point, here's a version of the circuits on the DSE prototype board. Ignore the 2 extra LEDs in the repeater circuit. Note the IC sockets supporting the Rx module – they can also be trimmed for the programming lead.

Since each lamp usually has an epoxy-covered four-wafer PC cell (delivering ~2V at 30mA) and a 600mAh NiCd, a 3-PV array will be sufficient to drive a module (probably the repeater) and charge four NiCds.

Average current demands of the Picaxe controlled units are around 10mA (much less when sleeping), meaning ~eight hours of daylight will be sufficient to run a setup and keep the batteries at full charge.

To avoid oversupplying the Picaxe-08M (which normally needs under 6V) and prevent battery discharge via the panel at night, a blocking diode should also be fitted.

Although cheap, silicon diodes waste 0.6V but conveniently the solar garden lamps again come to the party and provide a superior Schottky version (1N5817 etc) which drops only 0.2V.

Amazingly for the lamp price, further useful parts like an ultra-bright white LED lurk in the device for later projects – how can these things be made so cheaply?

Footnote for sunbelt regions: just as the photovoltaic (PV) panels need sunlight, you need to ensure that the repeater electronics aren't cooked by strong sun. It can happen!

Don't mount the repeater in too inconvenient a place either, as you'll no doubt need to access it for software upgrades and occasional dirt removal from the panels.

Birds naturally appreciate elevated roosts but their droppings (especially from seagulls) may be the weak point in a pico PV-powered system like this!

References:

For convenience these are hosted, along with mentioned URLs and project software, at **www.picaxe.orcon.net.nz/434rpt.htm.** SC

* **s.t.swan@massey.ac.nz**

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01-06

Vintage Radio

By RODNEY CHAMPNESS, VK3UG

The AWA B25/6 Stereogram

Towards the end of the valve era, the local radio industry began producing stereo versions of what used to be (mono) radiograms. These usually had a power output of several watts per channel and their bass response was often curtailed to stop acoustic feedback via the cabinet to the stereo pickup cartridge.

THIS AWA STEREOGRAM is similar in concept to most others of the era. Normal AM radio reception was in mono, with a standard converter and one stage of intermediate frequency (IF) amplification and detection.

From here on, the difference between a mono radiogram and a stereo radiogram is apparent. The audio system is split into two identical amplifiers feeding speakers at the left and righthand ends of the cabinet to give the stereo effect. Some stereograms used the normal mono radiogram cabinet and put the second speaker into a satellite speaker box. This meant that a better stereo effect could be achieved.

The AWA B25/6 is a single-cabinet stereogram which stands on four splayed legs. There is a 6 x 9-inch oval speaker at either end of the cabinet.

The radio and amplifier chassis is in the lefthand end and the controls are accessed under the lift-up lid above the 4-speed record changer.

To the right of the changer is a small area for storing a few 12-inch records. The righthand end is largely empty space with the second oval speaker situated in it. This was a relatively simple stereogram, designed to cater for the middle to low end of the market.

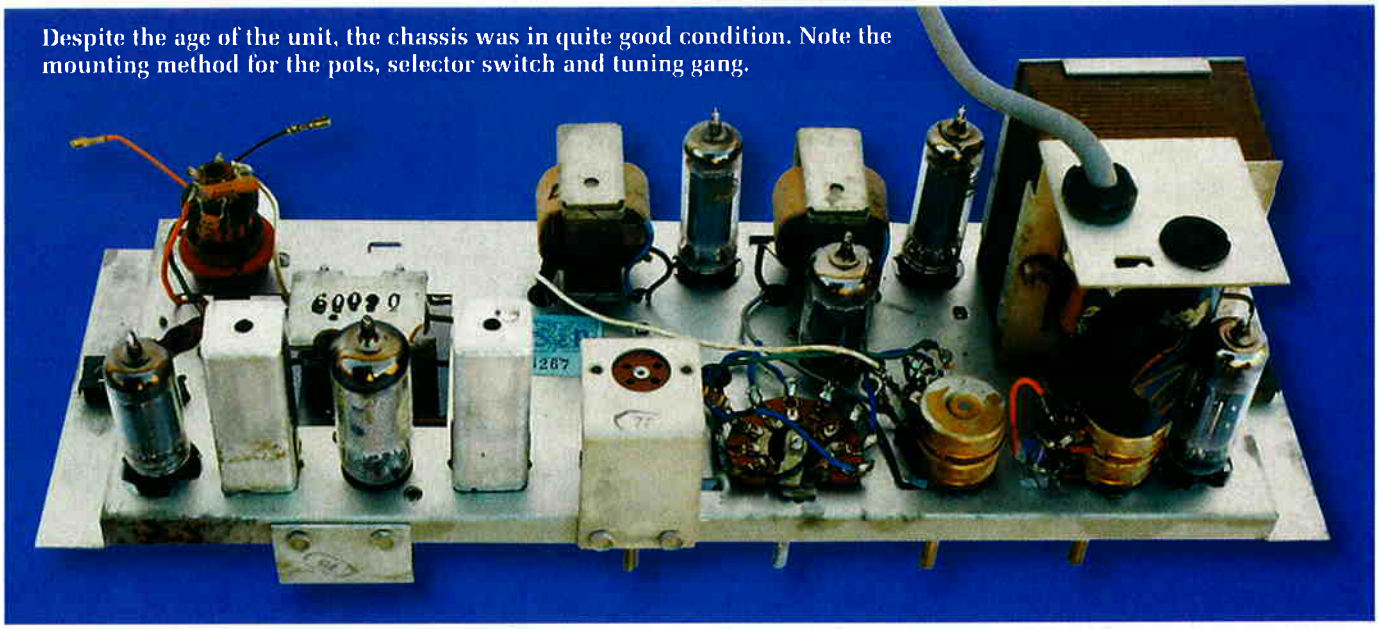
Removing the chassis

We all hope that the removal and reinstallation of the "works" from a cabinet will be easy and straightforward. While cleaning the dirt and muck off the cabinet, I looked carefully to see how the receiver chassis could be removed from the cabinet.

It looked like it could be a challenge. I'd seen the data on how to dismantle some of the slightly earlier models that appeared to be the same, as shown on the technical data sheets. However, close inspection revealed that the layout inside the record changer section was quite different to the ones in the data sheets.

I removed the knobs and could see that the chassis would drop down inside the cabinet if two mounting screws were removed. Before doing this, I placed the cabinet on its lefthand end and looked underneath again to see if access was available from the underside of the cabinet. Well it was. I removed three screws and the cover came off. I looked more carefully to see why only three screws were used on the underside of the cabinet to secure the cover.

The reason soon became quite obvious. The cover originally had been stapled to the underside of the cabinet and when it had to be



Despite the age of the unit, the chassis was in quite good condition. Note the mounting method for the pots, selector switch and tuning gang.

serviced in the past, the serviceman had to lever the staples out to remove the base.

I could now see the chassis and observed that if I removed the two retaining screws, the chassis would fall into the cabinet and probably break some valves. I then got the bright idea that if I removed the record changer I could gain access through the changer cutout and be able to remove the screws and support the chassis at the same time.

It was still a menace to disconnect the cables, as the connections were tight on some miniature spade connectors. With some difficulty, I managed to get the chassis out without damaging anything. After I had overhauled it, there was the job of putting the chassis back into the cabinet. I had to get extra help to do this but I got it back together.

Thinking there had to be a better way of doing this, I noticed four screw heads on the front of the cabinet I hadn't seen before – part of a decorative trim. I removed these and the front baffle with the two speakers on it came away from the cabinet. This would make it much easier to remove the chassis.

Further investigation showed an even better method: lay the cabinet on its right hand end and remove the base panel and the front speaker baffle. Once this is done, the chassis is reasonably easy to get at.

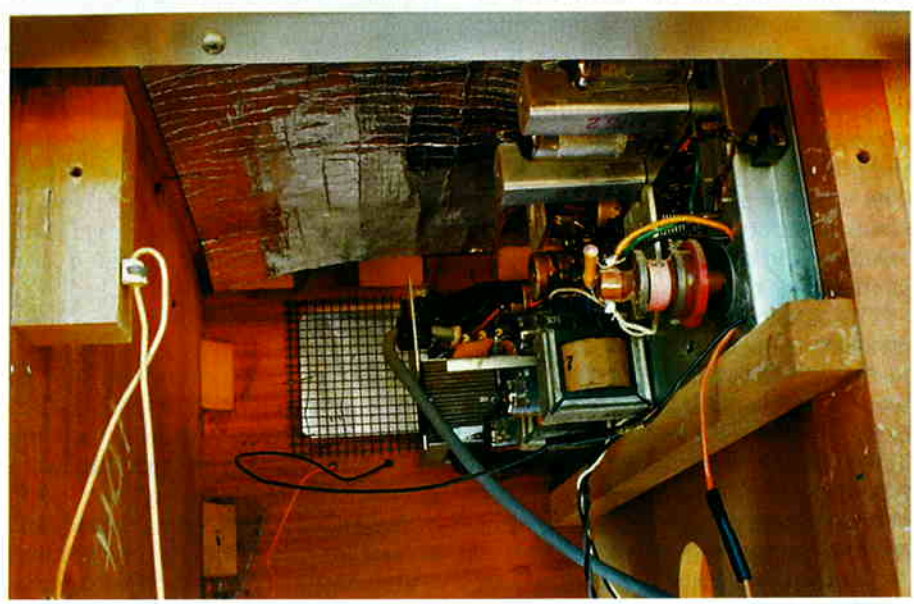
The moral of the story is to explore all possibilities of how to remove the innards of a set before jumping to the conclusion that the manufacturers had a fiendish delight in making it extremely difficult for servicemen or restorers. I still believe most manufacturers could have used more lateral thinking and come up with a much better means to gain access to the works.

While the chassis and record changer were out of the cabinet, the inside of the cabinet, the chassis and the record changer were cleaned with a brush and later with a kerosene-dampened rag. Mouse dung had to be cleaned out but the only damage was some corrosion on one edge of the chassis. The valves were taken out and cleaned with soapy water, taking care not to rub the valve type numbers off.

B25/6 circuit details

I'm not sure if the set is a B25 or a B26 as the chassis has no markings on it to indicate the model. However, the circuit appears to be similar to the AWA B20 which is shown as Fig.1 of this article.

The B25/6 is a 6-valve set and is quite conventional. The AM tuner section uses a 6BE6 as a converter and a 6N8 as the 455 kHz IF amplifier/AGC and detector. Each power amplifier uses one half of a 12AX7 twin triode and a 6AQ5 pentode as a single-ended



This view shows how the chassis is mounted vertically inside the cabinet (front speaker panel removed).

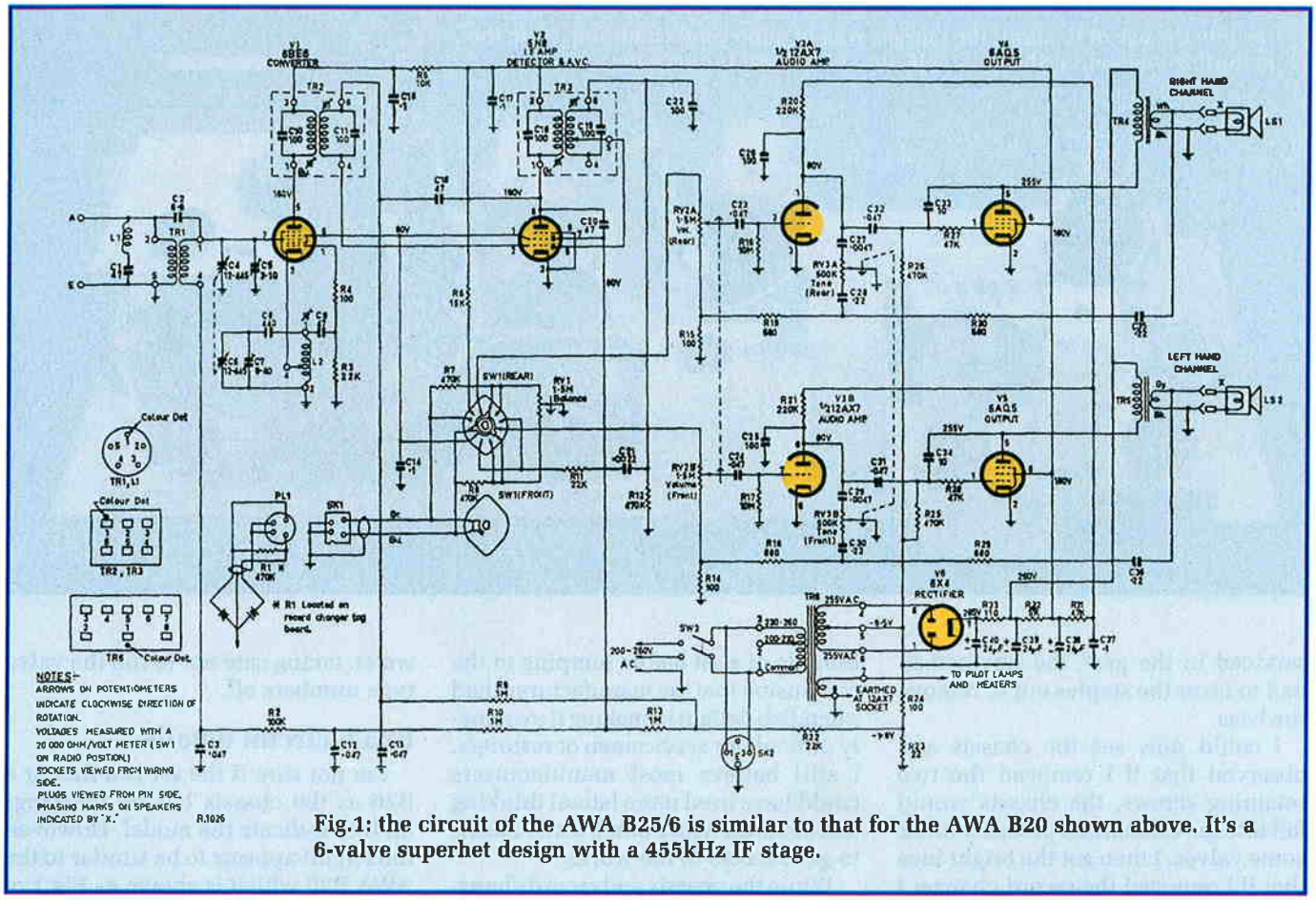

RIGHT HAND CHANNEL
LEFT HAND CHANNEL
TO PILOT LAMPS AND HEATERS
EARTHED AT 12AX7 SOCKET
NOTES:-
ARROWS ON POTENTIOMETERS INDICATE CLOCKWISE DIRECTION OF ROTATION.
VOLTAGES MEASURED WITH A 20 000 OHM/VOLT METER (SW1 ON RADIO POSITION)
SOCKETS VIEWED FROM WIRING SIDE.
PLUGS VIEWED FROM PIN SIDE. PHASING MARKS ON SPEAKERS INDICATED BY "X".
R.1026

Fig.1: the circuit of the AWA B25/6 is similar to that for the AWA B20 shown above. It's a 6-valve superhet design with a 455kHz IF stage.

class-A output stage. A 6X4 acts as the power supply rectifier.

Before I switch a set on, I always do a number of things to make sure that it is safe to do so. First, I checked that the earth pin of the mains plug was connected via the earth wire to the chassis, which it was. That done, I used my 1000V tester to check that there were no insulation breakdowns between the mains wiring to the chassis and to the secondary winding of the power transformer – all was well. The speaker transformers were then checked for continuity of the primary winding and once again they were in good order.

The next job was to check the resistors and capacitors. The resistors all tested within tolerance or if not, they were only a small amount out. The capacitors were a different matter. Tested at 500V, I found that all the AEE capacitors were much too leaky at 1MΩ to 5MΩ resistance and most of the UCC capacitors were no better.

The other capacitors were all in good condition. Where their leakage resistance would have affected the circuit's operation, defective capacitors were replaced.

Close inspection of the chassis also revealed a blue lead going through an eyelet on a soldering tag strip. Why this was done I don't know but it means that extreme care is needed to solder anything to the top lug so that the insulation on the blue wire doesn't melt.

The valve sockets and the gram/radio selector switch were given a squirt of Inox cleaner and the control shafts were oiled. With the valves installed, it was time to test the set. With an outside antenna connected and power applied, the set came up very nicely with full high tension voltage and a radio station playing in the background. Good reception was obtained right across the band. The performance was so good that I decided that the alignment was near enough and didn't need any tweaking.

The knobs were all in good condition except for one with a white pointer, which has cracks in the plastic. It appears to be a replacement and, unlike the others, lacks a metal collar.

To strengthen it, I wound three turns of 24-gauge tinned copper wire around it in the same position as the collars on the other knobs. I then twisted the two ends together, quickly soldered them and laid the soldered join down along the knob so that the repaired knob would fit down its escutcheon and onto the control. It worked well and the knob is now much stronger.

The record changer

The BSR Monarch record changer is one of the simplest around but for service it is necessary to remove it from the cabinet. This is done by removing the audio and power leads, then twisting the toggles on the two screws holding the changer in the cabinet so that they will slip through the mounting holes.

I've found this brand of record changer very reliable, requiring little in the way of fault-finding. This unit was no exception. However, as it is between 35 and 40 years old, the lubricants had dried out and needed to be replaced. I mounted the changer onto my servicing jig and then commenced

Photo Gallery: AWA Radiola 240 (1934)

Released by AWA in 1934, the Radiola 240 is a 7-valve superheterodyne console that tunes the medium-wave band and two shortwave bands. An interesting feature of the circuit was the use of two RF amplifier stages ahead of the mixer, with the first stage switched into use only when the higher-frequency shortwave range was selected. The valve line-up was as follows: 6D6 1st RF amplifier; 6D6 2nd RF amplifier; 6A7 frequency changer, 6D6 IF amplifier (460kHz); 6B7 audio amplifier/detector/AVC rectifier; 42 audio output; and 80 rectifier. Photo: Historical Radio Society of Australia, Inc.

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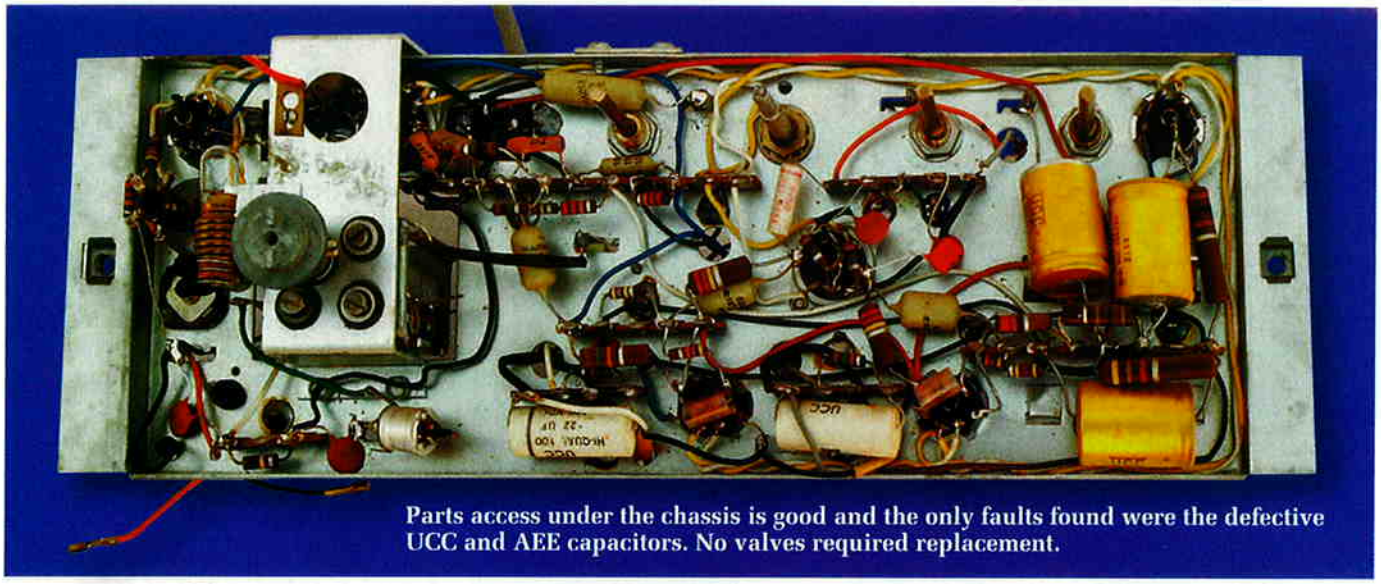
removing the platter. This is achieved by removing the circlip in the centre but first the turntable switch should be in the off position (to disengage the idler wheel) and the turntable should rotate easily in a clockwise direction. It should then be possible to ease the platter off its central shaft but in this case, it was reluctant to move upwards.

Fortunately, I had some fine hard-drawn steel wire from which I cut two lengths about 150 mm long. I put a hook in one end of both pieces and used them as a puller on the platter, twisting until it came free.

Like the rest of the mechanism, it needed lubrication. I oiled the central shaft and the idler pulley. The motor is mounted on rubber grommet resilient mounts. Three circlips were removed from the mounts and the motor dropped down under the platform.

Most of these motors can be dismantled by removing two screws. I did this but found that the bearings were not as accessible as in some other models. With some types, you can either lever a cover off the bearings or gain direct access to them. Usually alongside the bronze bearing is a felt wick which can be filled with oil to lubricate the bearing for many years. In this case, I just flooded the bearing and hoped that enough oil got to the wicks.

Oil is used on bearings and shafts and grease is used on many of the sliding surfaces of the changer. The old congealed grease can be cleaned off with a kerosene-soaked rag and general purpose grease applied in its place. This isn't an easy task and it may not always be possible to clean and replace all of the grease. It is just



Parts access under the chassis is good and the only faults found were the defective UCC and AEE capacitors. No valves required replacement.

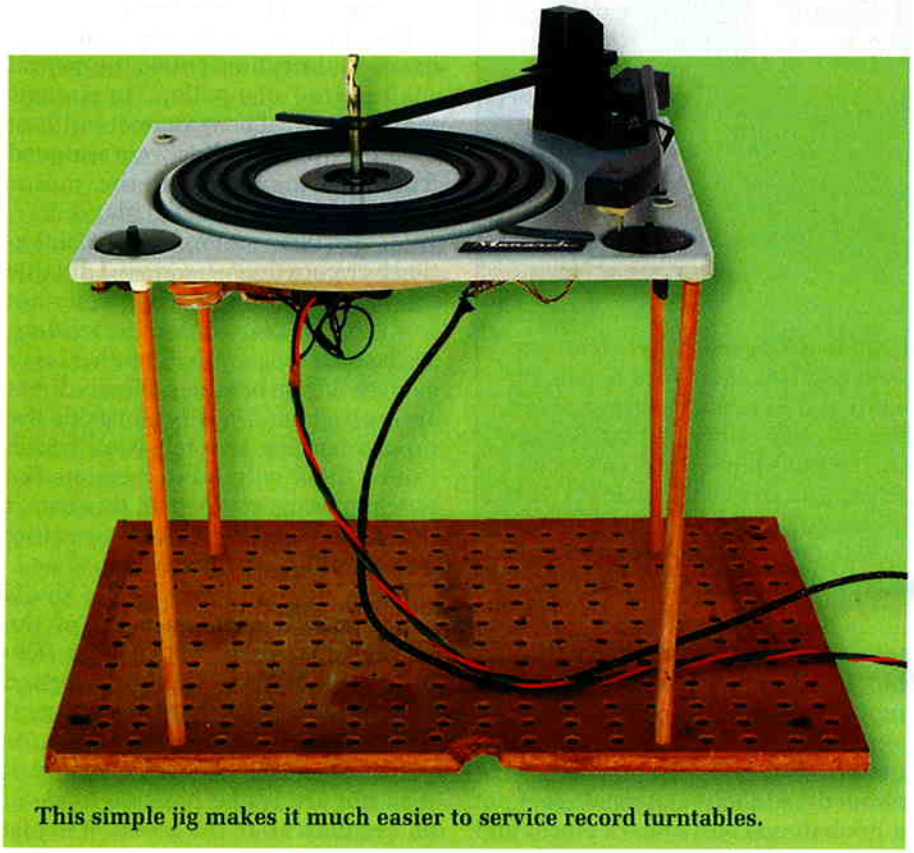
a matter of doing your best without dismantling the changer.

There are three adjustments on these mechanisms but they seldom require attention. The first is the set-down position of the stylus onto the record and this is accessed under the tone-arm near the pivot (a horizontal screw).

The second adjustment is the height of the tone-arm lift, accessed from the top of the tone-arm at the pivot point. This is adjusted so that the arm lifts high enough to clear a stack of six records. Mind you, it is not advisable to play a stack of six records on the changer. The weight of the stack on the spindle can easily damage the record centre holes, apart from any damage to the record surfaces from being in contact. Take my advice and play only one record at a time, to minimise any wear and tear.

The third adjustment sets the stylus tracking weight – normally around five or six grams for a piezoelectric cartridge of this type. This involves adjusting a spring on the underside of the tone-arm and is easily done.

The only other maintenance job is the replacement of the pick-up styli (78 and LP), as they have a fairly short life before becoming worn. A likely source of a suitable stylus for this and other radiograms is WES Components in Ashfield, NSW (phone 02 9797 9866). Purchase a diamond stylus rather than a sapphire one if possible, as they last considerably longer.



This simple jig makes it much easier to service record turntables.

Summary

The B25/6 is a fairly basic single unit stereogram. It suited Mr and Mrs Average's lounge-room decor of the era and did a creditable job of reproducing stereo records with pleasing audio quality. The radio performance is better than many receivers and the handspan dial is sufficiently large for accurate tuning. The set is reliable except for the use of the troublesome UCC and AEE capacitors. There was no other fault found and no valves required replacement.

Despite its age the receiver still had its instruction manual. The original instruction books, licences, repair dockets and original carton can all add to the value of a set, historically as well as monetarily.

I question the use of a 6X4 valve as the rectifier, as it is rated at a maximum of 70mA and a single 6AQ5 can draw around 45mA, although the 6AQ5s are drawing well under 45mA each in this set. Even so, I would have used a 6V4 rectifier which is rated at 90mA.

In summary, a nice set and worthy of a place in any collection. **SC**

Salvage It!

BY JULIAN EDGAR

Building a human-powered LED torch for next to nothing

Would you like to have a torch where you wind a knob just a few times and a white LED stays on brightly for two minutes and then remains visible for hours? Well you can and the only parts that you'll have to buy new are the LED and the box to mount everything in.

YOU'LL NEED A VARIETY of components from different salvaged goods to make this design, so it's one to keep in mind as you collect bits and pieces over a period.

First, you need the turntable motor from a microwave oven. This is an AC synchronous motor that's about 20mm high and 50mm in diameter. In addition to the motor, inside the package is a system of plastic reduction gears that normally gives an output shaft speed of just 5 RPM (or thereabouts). By turning this shaft with a knob, it's possible to easily generate up to several hundred volts AC output! There's our power source.

WARNING! Exercise extreme caution when salvaging parts from a microwave oven. The large capacitors in the EHT (extra high tension) power supply can retain a lethal charge, even after the power has been switched off.

Although these capacitors should be discharged by bleeder resistors when power is removed, don't take it for granted. Older microwave ovens may not be fitted with bleeder resistors, or the resistors may have gone open circuit. **For this reason, always make sure that the capacitors in the EHT supply have been discharged before removing parts from a microwave oven.**

The primary components needed are the turntable motor from a microwave oven, an old plugpack and some high-value, low-voltage capacitors. These salvaged parts shouldn't total more than a few dollars but be careful when salvaging the turntable motor – the bite from the EHT circuitry in a microwave oven can be lethal, even with the power off (see warning in article).

Plugpack bits

Next, a small transformer is need to step that voltage down to something that can be rectified (ie, converted to DC) and used to drive a LED. This can be done using one or more diodes or a bridge rectifier. And guess what – inside any older plugpack you'll find just those components, already wired up and ready to go!

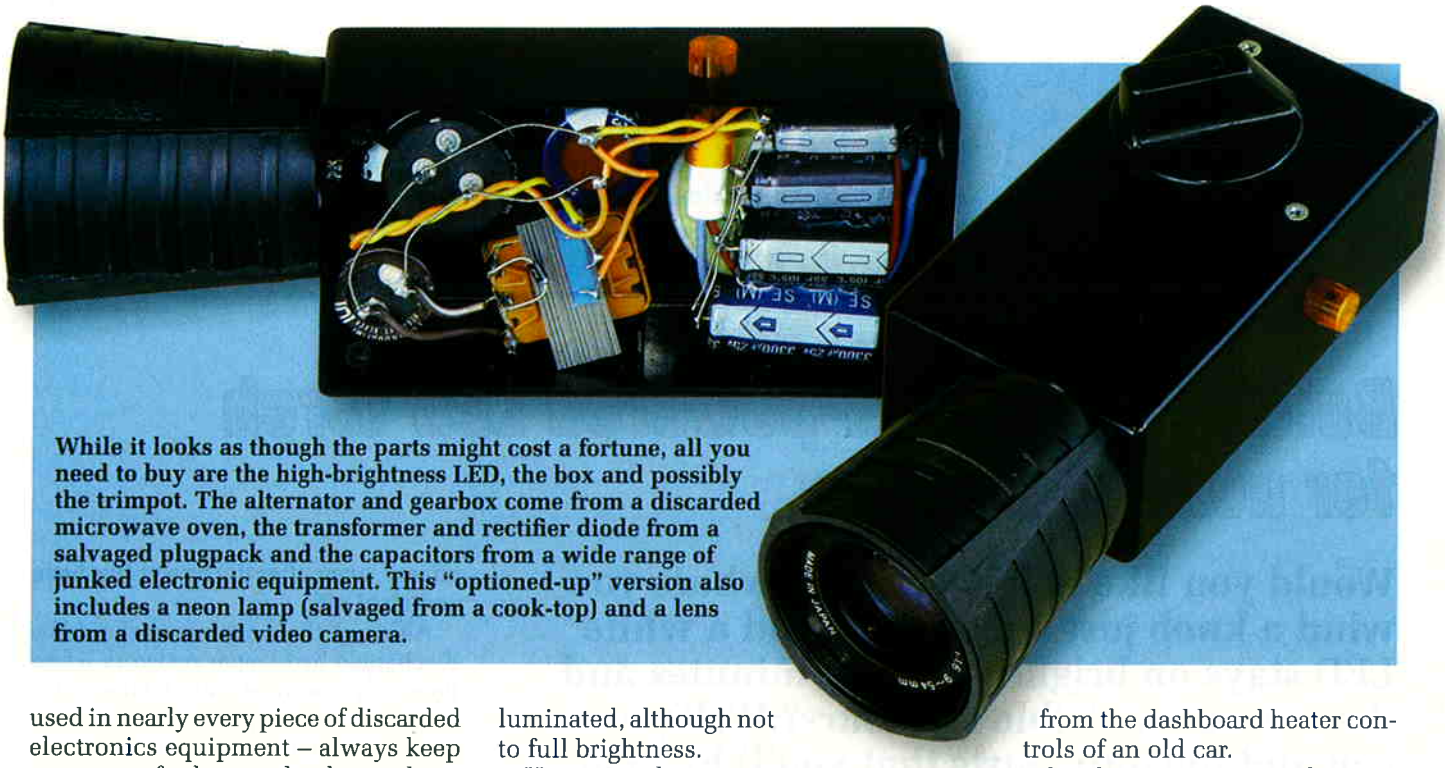
Don't pick a recent lightweight plugpack, though – these use switchmode circuits that don't work in this application. You can also recognise a switchmode design by the large number of internal components.

We tried a variety of older 240V plugpacks with transformers and those with nominal outputs in the range of 6-12V DC all worked well.

Energy storage

To store the power you've generated, you need lots of capacitors. In addition to being small enough to fit inside your chosen box, these should have as much capacitance as possible, while having a voltage rating of about 10-16V.

Several 10,000uF 10V capacitors are ideal, for example, but it doesn't matter if you use 10,000uF 16V caps instead. Electrolytic capacitors are



While it looks as though the parts might cost a fortune, all you need to buy are the high-brightness LED, the box and possibly the trimpot. The alternator and gearbox come from a discarded microwave oven, the transformer and rectifier diode from a salvaged plugpack and the capacitors from a wide range of junked electronic equipment. This "optioned-up" version also includes a neon lamp (salvaged from a cook-top) and a lens from a discarded video camera.

used in nearly every piece of discarded electronics equipment – always keep an eye out for large-value low-voltage units to salvage.

A 10-100kΩ trimpot (preferably multi-turn) will make it easy to set the LED current. Again, these can be salvaged from lots of gear but failing that, are cheap to buy new.

Another essential item is a suitable knob, so that the shaft of the motor/gearbox can be turned by hand. This knob will need to fit a D-shaped shaft and if you can't salvage one for nothing, you're not really trying!

White LED

You also need a white LED and this will probably have to be purchased. A 5mm high-brightness white LED works well. However, if you want more light output and are prepared to turn the knob more often, higher-rated units can be used.

For example, with this design, a 1W Luxeon LED can be strongly illuminated, although not to full brightness.

However, the more powerful the LED, the shorter the time the capacitor pack will keep it on after you've stopped turning the knob. With the 1W Luxeon, the capacitor pack will drive the LED for less than a second, so in many ways a lower rated LED is more practical. (Note: if you use a powerful LED, you should uprate the power rating of the current limiting resistor.)

Finally, if you want to build the "optioned-up" model, you'll need a lens (one salvaged from an old video camera is perfect) and a neon indicator from an old stove or cook-top.

Building it

To allow testing, roughly assemble the electronic circuitry for the torch on the bench before building the final version into a box.

The first step is fit the knob to the shaft. In my case, I used a knob taken from the dashboard heater controls of an old car.

That done, connect a multimeter set to "AC Volts" to the output of the motor (now working as an alternator!). Now turn the knob but make sure that you're not touching the output terminals. You should get a no-load output of 100–200V, depending on how fast you turn the knob. If you come in contact with the output when you are turning the knob, you will give yourself a shock, so be careful!

Note that you should never try to wind the knob flat out – you'll strip the gears inside if you do. Instead, just turn the knob progressively and evenly at a slow speed (the optioned-up model has this aspect covered)!

Before pulling the plugpack apart, follow this simple procedure to check that it is suitable. First, connect the plugpack's mains input terminals to the alternator outputs (polarity doesn't matter). That done, connect the plugpack's output to the capacitor pack,

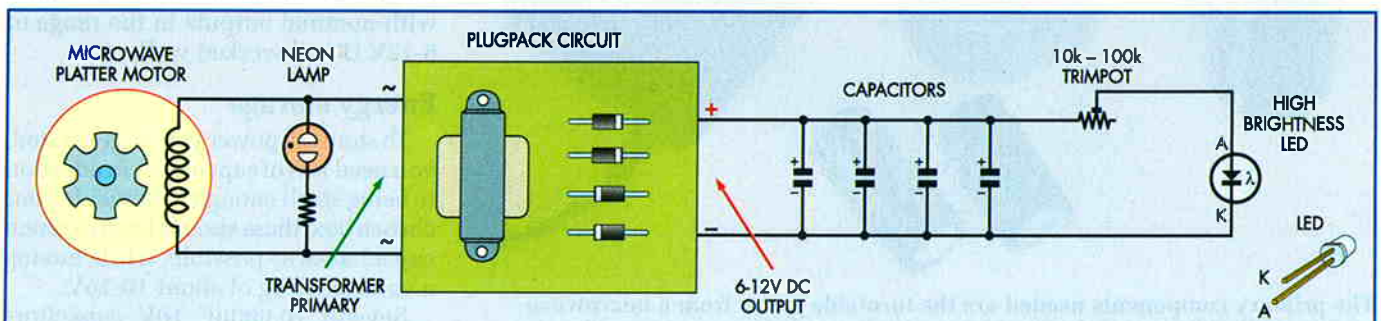
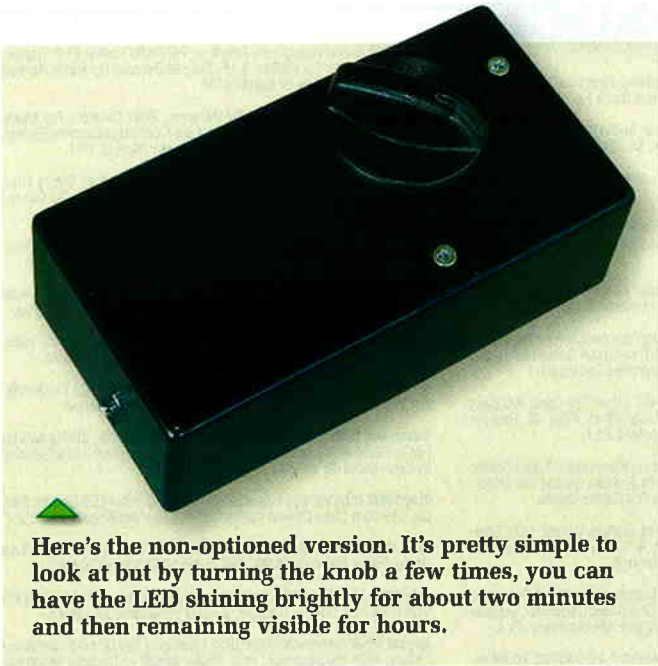
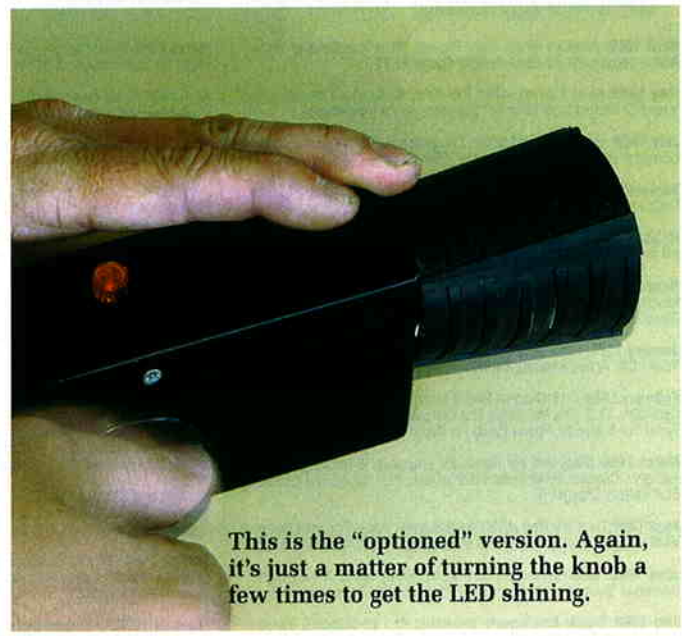


Fig.1: a salvaged microwave turntable motor is used as an alternator to generate high-voltage AC. This is then fed to a plugpack transformer and rectified to produce 6-12V DC by the innards of a plugpack. The capacitors are used for energy storage, while the trimpot allows the current through the LED to be adjusted to its rated value (or less).



Here's the non-optioned version. It's pretty simple to look at but by turning the knob a few times, you can have the LED shining brightly for about two minutes and then remaining visible for hours.



This is the "optioned" version. Again, it's just a matter of turning the knob a few times to get the LED shining.

taking care to connect negative output lead (usually black or non-striped) to the negative side of the pack.

Now connect your multimeter (set to Volts DC) across the capacitor pack and turn the knob. You should be able to read a voltage that gradually rises as you keep on turning. Any voltage from about 6-12V is fine.

The trimpot (wired as a variable resistor) and the LED can now be added to the circuit. The circuit will look like Fig.1, except you have to add your multimeter to measure the LED current. To do this, simply wire the multimeter (set to milliamps DC) in series with the LED.

Next, set the trimpot to its highest resistance and turn the alternator knob 10 times. It's then just a matter of slowly adjusting the trimpot until the maximum current rating of the LED is reached. For example, if the maximum current rating of the LED is 100mA, set the trimpot to provide this current flow. Check that further turning the alternator knob doesn't cause the required value to be exceeded.

Alternatively, you may want to set the trimpot so that the LED operates at less than full brightness, so that it stays on longer after you stop turning the knob.

Final assembly

The plugpack can be opened to retrieve the parts by crushing the case slowly in a bench vice until it cracks. That done, you can build the unit into an off-the-shelf jiffy box. Seal the box (eg, with silicone sealant) if the torch is to be used in the rain or in wet areas.

And the optioned-up model? Well, it includes a neon lamp wired straight across the alternator. This lights at any voltage over 70-100V (the voltage depends on the neon lamp) and so it's a good guide as to when the knob is being turned quickly enough to generate sufficient power. In practice, it should only just light.

Neon indicators salvaged from stoves and cook-tops already have a series resistor built into their bodies, in which case you can just wire it straight in.

The second option is to add a lens. Our prototype used a video camera lens, supported by a cut-down section from a Portaflood light. This is ideal if you want a long narrow beam – the prototype has a beam range of at least 100 metres! SC

Other Versions

In the February 2004 issue of SILICON CHIP we covered a different design of human-powered torch. That approach used a direct-drive stepper motor as the power source.

So what are the advantages of taking the approach shown here? Because of the built-in gearing of the microwave oven motor, you can generate much more power in a shorter time – just a few turns of the knob will keep the LED brightly lit for a reasonable period.

However, the use of a gearbox also has downsides – when being wound, the torch is noisier than a stepper motor design and the plastic gears have a finite life.

Rat It Before You Chuck It!

Whenever you throw away an old TV (or VCR or washing machine or dishwasher or printer) do you always think that surely there must be some good salvageable components inside? Well, this column is for you! (And it's also for people without a lot of dough.) Each month we'll use bits and pieces sourced from discards, sometimes in mini-projects and other times as an ideas smorgasbord.

And you can contribute as well. If you have a use for specific parts which can easily be salvaged from goods commonly being thrown away, we'd love to hear from you. Perhaps you use the pressure switch from a washing machine to control a pump. Or maybe you have a use for the high-quality bearings from VCR heads. Or perhaps you've found how the guts of a cassette player can be easily turned into a metal detector. (Well, we made the last one up but you get the idea . . .)

If you have some practical ideas, write in and tell us!

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November 2000: Santa & Rudolf Chrissie Display; 2-Channel Guitar Preampli er, Pt.1; Message Bank & Missed Call Alert; Protoboards – The Easy Way Into Electronics, Pt.3.

December 2000: Home Networking For Shared Internet Access; White LED Torch; 2-Channel Guitar Preampli er, Pt.2 (Digital Reverb); Driving An LCD From The Parallel Port; Index To Vol.13.

January 2001: How To Transfer LPs & Tapes To CD; The LP Doctor – Clean Up Clicks & Pops, Pt.1; Arbitrary Waveform Generator; 2-Channel Guitar Preampli er, Pt.3; PIC Programmer & TestBed.

February 2001: An Easy Way To Make PC Boards; L'il Pulser Train Controller; A MIDI Interface For PCs; Build The Bass Blazer; 2-Metre Groundplane Antenna; LP Doctor – Clean Up Clicks & Pops, Pt.2.

March 2001: Making Photo Resist PC Boards; Big-Digit 12/24 Hour Clock; Parallel Port PIC Programmer & Checkerboard; Protoboards – The Easy Way Into Electronics, Pt.5; A Simple MIDI Expansion Box.

April 2001: A GPS Module For Your PC; Dr Video – An Easy-To-Build Video Stabiliser; Tremolo Unit For Musicians; Minimitter FM Stereo Transmitter; Intelligent Nicad Battery Charger.

May 2001: 12V Mini Stereo Amplifier; Two White-LED Torches To Build; PowerPak – A Multi-Voltage Power Supply; Using Linux To Share An Internet Connection. Pt.1; Tweaking Windows With TweakUI.

June 2001: Universal Battery Charger, Pt.1; Phonome – Call, Listen In & Switch Devices On & Off; Low-Cost Automatic Camera Switcher; Using Linux To Share An Internet Connection, Pt.2; A PC To Die For, Pt.1.

July 2001: The HeartMate Heart Rate Monitor; Do Not Disturb Telephone Timer; Pic-Toc – A Simple Alarm Clock; Fast Universal Battery Charger, Pt.2; A PC To Die For, Pt.2; Backing Up Your Email.

August 2001: DI Box For Musicians; 200W Mosfet Amplifier Module; Headlight Reminder; 40MHz 6-Digit Frequency Counter Module; A PC To Die For, Pt.3; Using Linux To Share An Internet Connection, Pt.3.

September 2001: Making MP3s; Build An MP3 Jukebox, Pt.1; PC-Controlled Mains Switch; Personal Noise Source For Tinnitus; Directional Microphone; Using Linux To Share An Internet Connection, Pt.4.

November 2001: Ultra-LD 100W/Channel Stereo Amplifier, Pt.1; Neon Tube Modulator For Cars; Audio/Video Distribution Amplifier; Build A Short Message Recorder Player; Useful Tips For Your PC.

December 2001: IR Transceiver For PCs; 100W/Ch Stereo Amplifier, Pt.2; Pardy Lights Colour Display; PIC Fun – Learning About Micros.

January 2002: Touch And/Or Remote-Controlled Light Dimmer, Pt.1; A Cheap 'n'Easy Motorbike Alarm; 100W /Channel Stereo Amplifier, Pt.3; Build A Raucous Alarm; FAQs On The MP3 Jukebox.

February 2002: 10-Channel IR Remote Control Receiver; 2.4GHz High-Power Audio-Video Link; Touch And/Or Remote-Controlled Light Dimmer, Pt.2; Booting A PC Without A Keyboard; 4-Way Event Timer.

March 2002: Mighty Midget Audio Amplifier Module; 6-Channel IR Remote Volume Control, Pt.1; RIAA Pre-Amplifier For Magnetic Cartridges; 12/24V Intelligent Solar Power Battery Charger.

April 2002: Automatic Single-Channel Light Dimmer; Pt.1; Water Level Indicator; Multiple-Output Bench Power Supply; Versatile Multi-Mode Timer; 6-Channel IR Remote Volume Control, Pt.2.

May 2002: 32-LED Knightrider; The Battery Guardian (Cuts Power When the Battery Voltage Drops); Stereo Headphone Amplifier; Automatic Single-Channel Light Dimmer; Pt.2; Stepper Motor Controller.

July 2002: Telephone Headset Adaptor; Rolling Code 4-Channel UHF Remote Control; Remote Volume Control For The Ultra-LD Stereo Amplifier; Direct Conversion Receiver For Radio Amateurs, Pt.1.

August 2002: Digital Instrumentation Software For PCs; Digital Storage Logic Probe; Digital Therm./Thermostat; Sound Card Interface For PC Test Instruments; Direct Conversion Receiver For Radio Amateurs.

September 2002: 12V Fluorescent Lamp Inverter; 8-Channel Infrared Remote Control; 50-Watt DC Electronic Load; Spyware – An Update.

October 2002: Speed Controller For Universal Motors; PC Parallel Port Wizard; Cable Tracer; AVR ISP Serial Programmer; 3D TV.

November 2002: SuperCharger For NiCd/NiMH Batteries, Pt.1; Windows-Based EPROM Programmer, Pt.1; 4-Digit Crystal-Controlled Timing Module; Using Linux To Share An Optus Cable Modem, Pt.1.

December 2002: Receiving TV From Satellites; Pt.1; The Micromitter Stereo FM Transmitter; Windows-Based EPROM Programmer, Pt.2; SuperCharger For NiCd/NiMH Batteries; Pt.2; Simple VHF FM/AM Radio; Using Linux To Share An Optus Cable Modem, Pt.2.

January 2003: Receiving TV From Satellites, Pt 2; SC480 50W RMS Amplifier Module, Pt.1; Gear Indicator For Cars; Active 3-Way Crossover For Speakers; Using Linux To Share An Optus Cable Modem, Pt.3.

February 2003: PortaPal PA System, Pt.1; SC480 50W RMS Amplifier Module, Pt.2; Windows-Based EPROM Programmer, Pt.3; Using Linux To Share An Optus Cable Modem, Pt.4; Fun With The PICAXE, Pt.1.

March 2003: LED Lighting For Your Car; Peltier-Effect Tinnie Cooler; PortaPal PA System, Pt.2; 12V SLA Battery Float Charger; Little Dynamite Subwoofer; Fun With The PICAXE, Pt.2 (Shop Door Minder).

April 2003: Video-Audio Booster For Home Theatre Systems; Telephone Dialler For Burglar Alarms; Three PIC Programmer Kits; PICAXE, Pt.3 (Heartbeat Simulator); Electric Shutter Release For Cameras.

May 2003: Widgybox Guitar Distortion Effects Unit; 10MHz Direct Digital Synthesis Generator; Big Blaster Subwoofer; Printer Port Simulator; PICAXE, Pt.4 (Motor Controller).

June 2003: PICAXE, Pt.5; PICAXE-Controlled Telephone Intercom; PICAXE-08 Port Expansion; Sunset Switch For Security & Garden Lighting; Digital Reaction Timer; Adjustable DC-DC Converter For Cars; Long-Range 4-Channel UHF Remote Control.

July 2003: Smart Card Reader & Programmer; Power-Up Auto Mains Switch; A "Smart" Slave Flash Trigger; Programmable Continuity Tester; PICAXE Pt.6 – Data Communications; Updating The PIC Programmer & Checkerboard; RFID Tags – How They Work.

August 2003: PC Infrared Remote Receiver (Play DVDs & MP3s On Your PC Via Remote Control); Digital Instrument Display For Cars, Pt.1; Home-Brew Weatherproof 2.4GHz WiFi Antennas; PICAXE Pt.7.

September 2003: Robot Wars; Krypton Bike Light; PIC Programmer; Current Clamp Meter Adapter For DMMs; PICAXE Pt.8 – A Data Logger; Digital Instrument Display For Cars, Pt.2.

October 2003: PC Board Design, Pt.1; JV80 Loudspeaker System; A Dirt Cheap, High-Current Power Supply; Low-Cost 50MHz Frequency Meter; Long-Range 16-Channel Remote Control System.

November 2003: PC Board Design, Pt.2; 12AX7 Valve Audio Preampli er; Our Best Ever LED Torch; Smart Radio Modem For Microcontrollers; PICAXE Pt.9; Programmable PIC-Powered Timer.

December 2003: How To Receive Weather Satellite Images; Self-Diagnostics Plug For Cars; PC Board Design, Pt.3; VHF Receiver For Weather Satellites; Linear Supply For Luxeon 1W Star LEDs; 5V Meter Calibration Standard; PIC-Based Car Battery Monitor; PICAXE Pt.10.

January 2004: Studio 350W Power Amplifier Module, Pt.1; High-Efficiency Power Supply For 1W Star LEDs; Antenna & RF Preamp For Weather Satellites; Lapel Microphone Adaptor For PA Systems; PICAXE-18X 4-Channel Datalogger, Pt.1; 2.4GHZ Audio/Video Link.

February 2004: PC Board Design, Pt.1; Supply Rail Monitor For PCs; Studio 350W Power Amplifier Module, Pt.2; Shorted Turns Tester For Line Output Transformers; PICAXE-18X 4-Channel Datalogger, Pt.2.

March 2004: PC Board Design, Pt.2; Build The QuickBrake For Increased Driving Safety; 3V-9V (or more) DC-DC Converter; ESR Meter Mk.2, Pt.1; PICAXE-18X 4-Channel Datalogger, Pt.3.

April 2004: PC Board Design, Pt.3; Loudspeaker Level Meter For Home Theatre Systems; Dog Silencer; Mixture Display For Cars; ESR Meter Mk.2, Pt.2; PC/PICAXE Interface For UHF Remote Control.

May 2004: Amplifier Testing Without High-Tech Gear; Component Video To RGB Converter; Starpower Switching Supply For Luxeon Star LEDs; Wireless Parallel Port; Poor Man's Metal Locator.

June 2004: Dr Video Mk.2 Video Stabiliser; Build An RFID Security Module; Fridge-Door Alarm; Courtesy Light Delay For Cars; Automating PC Power-Up; Upgraded Software For The EPROM Programmer.

July 2004: Silencing A Noisy PC; Versatile Battery Protector; Appliance Energy Meter, Pt.1; A Poor Man's Q Meter; Regulated High-Voltage Supply For Valve Amplifiers; Remote Control For A Model Train Layout.

August 2004: Video Formats: Why Bother?; VAF's New DC-X Generation IV Loudspeakers; Video Enhancer & Y/C Separator; Balanced Microphone Preamp; Appliance Energy Meter, Pt.2; 3-State Logic Probe.

September 2004: Voice Over IP (VoIP) For Beginners; WiFry – Cooking Up 2.4GHz Antennas; Bed Wetting Alert; Build a Programmable Robot; Another CFL Inverter.

October 2004: The Humble "Trannie" Turns 50; SMS Controller, Pt.1; RGB To Component Video Converter; USB Power Injector; Remote Controller For Garage Doors & Gates.

November 2004: 42V Car Electrical Systems; USB-Controlled Power Switch (Errata Dec. 2004); Charger For Deep-Cycle 12V Batteries, Pt.1; Driveway Sentry; SMS Controller, Pt.2; PICAXE IR Remote Control.

December 2004: Build A Windmill Generator, Pt.1; 20W Amplifier Module; Charger For Deep-Cycle 12V Batteries, Pt.2; Solar-Powered Wireless Weather Station; Bidirectional Motor Speed Controller.

January 2005: Windmill Generator, Pt.2; Build A V8 Doorbell; IR Remote Control Checker; 4-Minute Shower Timer; The Prawnlite; Sinom Says Game; VAF DC-7 Generation 4 Kit Speakers.

February 2005: Windmill Generator, Pt.3; USB-Controlled Electrocardiograph; TwinTen Stereo Amplifier; Inductance & Q-Factor Meter, Pt.1; A Yagi Antenna For UHF CB; $2 Battery Charger.

March 2005: Windmill Generator, Pt.4; Sports Scoreboard, Pt.1; Swimming Pool Lap Counter; Inductance & Q-Factor Meter, Pt.2; Shielded Loop Antenna For AM; Cheap UV EPROM Eraser; Sending Picaxe Data Over 477MHz UHF CB; $10 Lathe & Drill Press Tachometer.

April 2005: Install Your Own In-Car Video (Reversing Monitor); Build A MIDI Theremin, Pt.1; Bass Extender For Hi Systems; Sports Scoreboard, Pt.2; SMS Controller Add-Ons; A $5 Variable Power Supply.

May 2005: Getting Into Wi-Fi, Pt.1; Build A 45-Second Voice Recorder; Wireless Microphone/Audio Link; MIDI Theremin, Pt.2; Sports Scoreboard, Pt.3; Automatic Stopwatch Timer.

June 2005: Wi-Fi, Pt.2; The Mesmeriser LED Clock; Coolmaster Fridge/Freezer Temperature Controller; Alternative Power Regular; PICAXE Colour Recognition System; AVR200 Single Board Computer, Pt.1.

July 2005: Getting Into Wi-Fi, Pt.3; Remote-Controlled Automatic Lamp Dimmer; Lead-Acid Battery Zapper; Serial Stepper Motor Controller; AVR200 Single Board Computer, Pt.2; Salvaging & Using Thermostats; Unwired Modems & External Antennas; PICAXE in Schools, Pt.3.

August 2005: Mudlark A205 Valve Stereo Amplifier, Pt.1; Programmable Flexitimer; Carbon Monoxide Alert; Serial LCD Driver; Enhanced Sports Scoreboard; Salvaging Washing Maching Pressure Switches.

September 2005: Build Your Own Seismograph; Bilge Sniffer For Boats; VoIP Analog Phone Adaptor; Mudlark A205 Valve Stereo Amplifier, Pt.2; PICAXE in Schools, Pt.4.

October 2005: A Look At Google Earth; Dead Simple USB Breakout Box; Studio Series Stereo Preamplifier, Pt.1; Video Reading Aid For Vision Impaired People; Simple Alcohol Level Meter; Ceiling Fan Timer.

November 2005: Good Quality Car Sound On The Cheap; Pt.1; Microbric – Robotics For Everyone; PICAXE In Schools, Pt.5; Studio Series Stereo Headphone Amplifier; Build A MIDI Drum Kit, Pt.1; Serial I/O Controller & Analog Sampler; Delta XL02 Tower Loudspeaker System.

December 2005: Good Quality Car Sound On The Cheap; Pt.2; Building The Ultimate Jukebox, Pt.1; Universal High-Energy Ignition System, Pt.1; Remote LED Annunciator For Queue Control; Build A MIDI Drum Kit, Pt.2; 433MHz Wireless Data Communication.

PLEASE NOTE: issues not listed have sold out. All other issues are in stock. We can supply photostat copies from sold-out issues for $8.80 per article (includes p&p). When supplying photostat articles or back copies, we automatically supply any relevant notes & errata at no extra charge. A complete index to all articles published to date can be downloaded free from our web site: **www.siliconchip.com.au**

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Garage door indicator wanted

Do you have a design for a garage door monitor which would transmit the state of the door to an indicator in the house? I have seen a commercial design which mounts a reflector on the door and then sends an infrared beam to that reflector. It has a radio link to the house-mounted indicator. (K. A., Sale, Vic).

● We do not have a suitable design although it would probably be possible to adapt the 4-channel UHF remote switch using latched outputs on the decoder. This was published in the July 2002 issue.

Recording LPs onto CDs

Have you ever published a circuit for a cheap phono preamp to connect to a computer using the computer's 12V supply and maybe an LM833. This would enable you to record old records onto HDD and burn MP3 CDs – all for under $10.

I think a lot of people have old records that they would like to transfer to CD and a cheap preamp powered by the computer power supply would be an alternative. (R. B., via email).

● Have a look at our RIAA Preamplifier for Magnetic Cartridges in the March 2002 issue. This uses a total supply voltage of 30V (ie, +15V, -15V) to get good overload margin from the preamp. It is not possible to get a sufficient overload margin from an RIAA preamp using only a 12V supply.

Double-heading with the Li'l Pulser

I have seen part of the article on "Li'l Pulser Train controller" (SILICON CHIP, February 2001). It may do the job I want but I would like to know if it is capable of running more than one loco (up to three). Also, where can I get a kit if one is available or a PC board? (R. H., via email).

● The specified power supply is rated at 1A, so it depends on how much your locos draw. It should cope with at least two.

If you use a bigger power supply and mount the Mosfet on a bigger heatsink, the circuit can deliver a lot more power and so you could hook up more locos. However, it is generally advisable to use identical locos when "double-heading" otherwise one loco will try to do the lion's share and will end up spinning its wheels. The kit is available from Jaycar (Cat. KC-5304).

High-power ultrasonic pigeon deterrent

We need to amplify ultrasonic signals to over 100dB. I plan on using a Stamp 2 module to generate the signals and feed them to your Studio 350 Amplifier. We want to generate these frequencies to repel seagulls and pigeons from factory roofs.

We have done our tests and believe we know what sequence of frequencies is required. They range from 15-30kHz. We need to connect up to 40 tweeters (Jaycar Cat. CT-1912), all with 100m of cable to a central box which includes the microcontroller and amplifier.

A salesperson at Jaycar Electronics said the Studio 350 will handle frequencies up to 60kHz so I presumed it would be good enough to amplify the frequencies generated from my microcontroller. What type of PA would you recommend I need to interface to the amplifier to achieve this? (V. J., St Albans, NSW).

● Unfortunately, your scheme won't work. For a start, the Studio 350 is not suitable for high power delivery at supersonic frequencies. Its output filter will burn out and the output transistors will all overheat. It would need a substantial re-design to make it suitable.

Second, it could not drive 40 tweeters, or anything like that number, and that particularly applies if the tweeters you propose to use are piezoelectric. This is because piezo tweeters are capacitive and therefore their impedance is very low at supersonic frequencies.

We do not know of any amplifier design which will deliver its rated power at 30kHz, let alone 60kHz. While typical audio amplifiers may have a frequency response to 100kHz and beyond, their power response is typically not much beyond 20kHz.

6V Operation For New Ignition System

I have already purchased a kit for the new version of the Electronic Ignition, as featured in the December 2005 issue. I am pleased that you have achieved a reduction in the coil current (coil heating) because the application I have in mind (a motorcycle restoration) has "delicate" coil hardware and excess heating has resulted in dead coils. It is a 6V motorcycle and coils for these are getting hard to source.

This brings me to my first question: could this project be used for a 6V application? Would this new version be more frugal in the watts department and would it function on a (kick-start) motorcycle with only a 6V supply?

Finally, I was disappointed to note that there has been no reduction in the size of the case. There simply isn't room on a modern (post 1960) motorcycle for a large diecast box! With the reduction achieved in coil current, couldn't some reduction in box size be achieved? (R. J., via email).

● The new ignition system will work on a 6V battery. And you could use a box smaller in height, provided the power transistor was mounted horizontally inside the case.

You would need an amplifier specially designed to drive piezo electric transducers, as in high-power ultrasonic cleaning baths.

Ultimately, you would probably be better off using a very high power frequency-modulated oscillator, with transformer coupling to the tweeters. We have used a similar approach in past projects to discourage dogs from barking: (1) Woofer Stopper Mk2, February 1996; (2) Dog Silencer, July 1999; and (3) Dog Silencer Mk2, April 2004.

We can supply these articles at $8.80 each, including postage. You could take the same approach but at a much higher power level. The circuits all use power Mosfets in the output so it would be possible to increase the power substantially by using more Mosfets but the gate drive circuits would also have to be considerably beefed up.

The transformer would be a specially wound job. We suggest you contact Harbuch Electronics. Phone (02) 9476 5854.

Where to obtain 240VAC-rated resistors

A number of your projects use 240VAC-rated resistors (eg, Philips VR25 1.2MΩ). I have not been able to find a supplier for these type of resistors. Could you advise of any known retailers, especially in the Canberra region? (I. F., via email).

● VR25 resistors (0.25W, 1150VAC rated) are available from Farnell, phone 1300 361 005 or browse to **www.farnellinone.com.au**. The stock number for a 1.2MΩ resistor is 341629 or 9477152, while a 1.5MΩ resistor as used in the Fan Timer (SILICON CHIP, October 2005) has a stock number of 341630 or 9477160.

Multiple message mode for voice recorder

I purchased the Voice Recorder kit (SILICON CHIP, May 2005) and it operates in single message mode with no faults. I have now programmed the module to run in random access mode for eight fixed messages, having installed the extra pushbuttons which now become the record/start play for each message. I have not been able to work out how to record the individual messages though.

Could you please advise me how to do this? (M. I., via email).

● In addition to adding the extra pushbutton switches to trigger each of the eight message areas individually for random-access operation, you also need to switch the RE-bar (record enable) input of the HK828 chip (pin 27) high for recording mode and low for playback mode. If you do this, you should find that it works correctly.

After-market chip for Land Rover

I am considering installing an after-market computer chip in a Land Rover Discovery. Can you tell me whether this is a safe modification and is a plug-in unit better than making changes to the settings in the ECU? (N. W., via email).

● We are not in a position to make recommendations concerning ECU chips for cars. However, unless the chip has been specifically tailored for your vehicle, it is unlikely to provide any improvements to the engine.

If you want a tailored system, you will be best served by a workshop team who can dyno tune the engine and alter the code within the ECU. Any over-the-counter chips that simply plug into the ECU cannot be guaranteed to provide any improvements and may cause engine damage.

Unmute for portable PA

I have built two PortaPAL PA kits (SILICON CHIP, February & March 2003) which work well and are good value for money. I would like to be able to bypass the "Mute" stage during a live performance, to prevent the truncation of the first few seconds of a song.

Is it possible to do this and if so, how can I go about it? (D. R., via email).

● Pin 4 of IC9 (TDA1562Q) should be tied to +12V to disable the muting. The connection to pin 7 of IC6b should be

Triac Failure in USB Powerboard

I built two of USB-activated powerboards (SILICON CHIP, November 2004) and they worked fine for a while. The Triac in both units then failed short-circuit between pins 1 & 2 and powers the board at all times, even when the computer is off.

I measured the worst-case current draw of my three peripherals – a small desk fan, scanner and printer – at 0.1A, 0.2A and 2.4A, respectively. This appears well within the 3A limit for the board. I replaced the Triac in one unit with a BT136 600E, which is the same as was supplied in the Jaycar kit. This too failed after four days, in the same manner as the original.

I referred to the parts list in the Jaycar instructions and note that it calls for a BT136 6A 500V unit but the parts layout lists a BT136F. My perusal of the specifications of both online seem to show they are compatible. Should I be using a BT136F, a small heatsink or are my peripherals too close to the current limit? (F. W., via email).

● There is not much difference between the BT137F-600 Triac which we originally specified and the BT136F-600 device which we understand Jaycar have supplied in their kits. The main difference is that the BT137F has higher RMS and peak non-repetitive current ratings – 8A and 55A respectively versus the 4A and 25A ratings for the BT136F.

As you suggest, these differences shouldn't normally make much difference in the USB Powerboard project, because the average load current should be below 3A anyway and the peak currents shouldn't even reach 25A.

You don't advise in your email where you are operating your own unit but if it's in the country, your power lines may be subject to fairly severe "spikes" due to lightning strikes, etc. Perhaps these could have caused the damage.

We suggest that you try replacing the damaged Triacs with BT137F-600 or even BT137F-800 devices if you can get them, to make the units more "rugged". It might also be a good idea to feed your computer and the USB powerboard through a power line filter and surge suppressor unit.

Mobile Phone Jammer Wanted

Have you ever produced, intend to produce or would consider producing a mobile phone jammer (if this is possible)? I work in a customer service field and there is nothing more frustrating than the rude customer who comes up to the counter while talking on their mobile phone, or indeed even takes a call at the counter and expects you and all those behind them to wait while they complete their call.

I see this happening with increasing regularity, not only at my place of work but also at the supermarket, bank, post office, and anywhere else I find I need to queue.

It would ideally be a low-powered unit that could be concealed on your person, with a range of about two metres or so, and able to be left on all day so it affected all phones within range and prevented then from ringing in the first place, or caused them to drop out as they were brought into range. (T. L., via email).

● You want a "cone of silence", don't you? We doubt whether there is any low-power jamming device which would be effective on a mobile phone (and if there was, it would be illegal). As you know, two or more mobile phones can be used in fairly close proximity without interference to each other.

People who behave like that are very annoying though!

broken when doing this. A single-pole double-throw (SPDT) switch could be used with the wiper of the switch connecting to pin 4 of IC9. Connect +12V to one side of the switch and pin 7 of IC6b to the other side.

There is a link on the PC board between IC7 and IC8 that connects pin 4 of IC9 to pin 7 of IC6b. This can be cut to enable the switch connection, while +12V can be obtained at pin 7 of IC8.

What are impedance protected motors?

What does "Impedance Protected" mean? The statement "Impedance Protected" appears on a new in-line ventilation 240V fan I am using. I know it's an induction motor type, so I guess it has something to do with protecting the motor's windings. But I don't know how, what or why.

I have asked my father this, as he's a Visiting Professor Of Faculty Of Engineering. He doesn't know either, which is strange. Perhaps you can answer this interesting question. (A. B., via email).

● Impedance protection prevents motor burnout if the fan is jammed. It is achieved by having high resistance windings, normally in a shaded-pole motor.

IR train detector needs pulsed signal

I have made several attempts to construct an IR train detector for my model train. I have found circuits in my model rail books dating back 10 years. I have also bought kits, some too expensive to duplicate and others where the parts are not clearly marked or the provider will not tell me the component values.

The circuit I have sent to you is the easiest one I have found but the LED is on all the time when I apply 12V filtered DC. I have tried changing the value of R1 downwards and have also tried D1 and Q1 from different sources to no avail.

Could you help me out here? I am a novice electronics user, although I have had previous success with other circuits. (G. J., via email).

● We are unable to assist with troubleshooting of circuits not published by us. We have not published an IR train detector but would suggest that you could base one on the infrared light beam relay in the December 1991 issue or the Infrared Sentry in the April 1999 issue. Both circuits use a pulsed IR signal – any other approach is futile.

Projects suitable for diesel vehicles

Are the projects described in "Performance Electronics for Cars" suitable for diesel vehicles? I bought the book so that I could build the Intelligent Turbo Timer device for my vehicle which is a turbo diesel. What other projects in the book are applicable to diesels? (G. B., via email).

● Most of the projects are applicable to diesels. These include the timer, the frequency, temperature and voltage switches, speedo corrector and thermometer. The adjusters may or may not be applicable, depending on the type of engine management in the diesel vehicle. SC

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely.

Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine. Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

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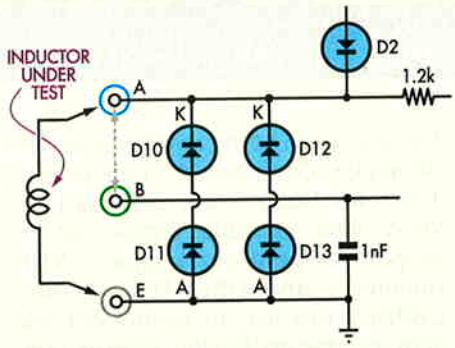
Notes & Errata

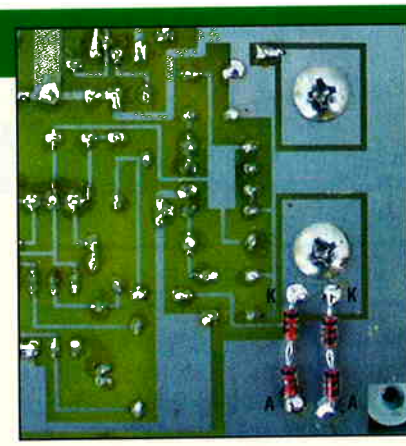
Inductance & Q-factor Meter (February & March 2005): an update for the AT90S2313 microcontroller firmware (v1.1) is now available from our website. The update incorporates two major changes from the initial release, which are: (1) the meter now reads up to 10mH as originally described; and (2) the meter indicates when both L and Q values are out of bounds (indicated by the letter "E" on the display).

In addition, to improve meter performance when measuring certain combinations of L & Q, install two pairs of series diodes in parallel with the test terminals, as shown in the accompanying circuit diagram. The diodes can be fitted on the copper side of the PC board (see photo) and must be 1N4148 small-signal types. The diodes act as dampers, serving to lower the peak of the ringing waveform to below 1.2V as quickly as possible.

The author also offers the following additional information on the meter's operation in regard to out-of-bounds detection and display:

The meter measures frequency and decay constant, so L and Q are derived quantities. This means that a Q value will be out of bounds when the meter can not acquire sufficient periods of oscillatory decay to reliably calculate a decay constant. This can occur for one of three reasons: (1) the Q is too low; (2) the Q is too high, so that negligible decay is observed on the scale of several hundred oscillations; or (3) the decay occurs on a very large time scale outside the range of the meter (this can occur when the measured frequency drops to several tens of kilohertz).





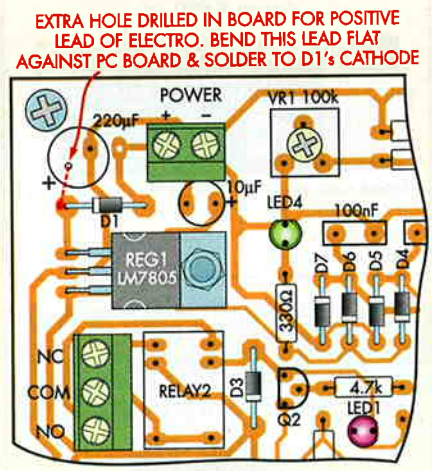
Note that an out-of-bounds Q does not automatically indicate that L and F are also unobtainable. These parameters will continue to be displayed, although their precision generally drops to around 10-20% of nominal. If no stable value for F can be had, then the L and F displays will blank out and a sole "E" will show in the Q position.

Constructors should also be aware that LC circuits can have parasitic oscillations. If these are large, they can register as an incorrect value for L.

This occurs because some inductors can not be well approximated by a simple theoretical L, so there is no unique answer to "what is the value of this inductor?". Nevertheless, the value derived from the frequency of oscillation with a given capacitor is a perfectly legitimate result, though if one were to make measurements at other frequencies, or use V = L x dI/dt to get L, a different answer could be obtained. In other words, some thought must be given to the details of the measurement, rather than relying solely on the instrument to produce the magic number!

IO Controller, November 2005: the PC board pattern erroneously connects the positive lead of the 220µF supply-rail filter capacitor to the anode of diode D1. It should instead go to D1's cathode. The circuit diagram on page 73 (Fig.3) of November 2005 is correct.

While the circuit will still work in this configuration, there is no reverse polarity protection for the 220µF capacitor if the power supply is connected the wrong way around. The solution is to mount the 220µF capacitor as shown in the accompanying diagram. This involves drilling a small hole in the PC board at the indicated location, to accept the capacitor's positive lead. This lead is then be bent flat against the PC board and soldered to D1's adjacent cathode pad.



Note that only early kit versions should need this modification, as later kit versions will be supplied with a corrected PC board. Check your supplied PC board carefully to see if the modification is necessary.

In addition, there was a bug in the Windows interface software that prevented the input values from being displayed on machines running Windows XP. This has now been corrected and the revised software posted on our website.

Universal High-Energy Ignition System, December 2005: there are several errors in the parts list published in Pt.1. In the main section, there should be three (not two) 100µF capacitors, the LM2940CT-5 regulator should be designated REG1 and there should be three (not two) crimp eyelets. In addition, the 22Ω resistor listed under the "Optical Pickup Version" heading should in fact be 22kΩ.

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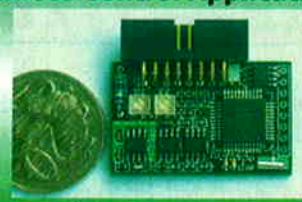

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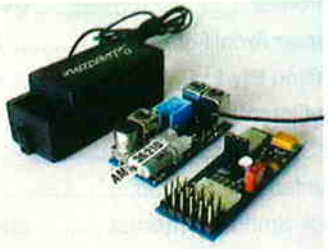

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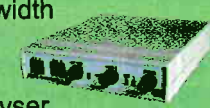

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